Allison

GM
GENERAL MOTORS

SERVICE SCHOOL TRAINING MANUAL

for

ALLISON J-33 AIRCRAFT ENGINE

PRELIMINARY

ALLISON DIVISION
of
GENERAL MOTORS CORPORATION
INDIANAPOLIS, INDIANA, U. S. A.

R. E. Schweiger
3235 W 116 St

1-23-47

RESTRICTED

ALLISON SERVICE SCHOOL

TRAINING MANUAL

This Training Manual is to be used as a general training guide and for information only. It contains information affecting the National Defense of the United States within the meaning of the Espionage Act (U.S.C. 50: 31:32) as amended. The transmission of this document or the revelation of its contents in any manner to an unauthorized person is prohibited by law.

Compiled by Allison Service School Department

ALLISON DIVISION

GENERAL MOTORS CORPORATION

INDIANAPOLIS, INDIANA

U. S. A.

INFORMATION ONLY

MAY 1, 1945
PRELIMINARY

RESTRICTED

INDEX TO SECTION 1

DESCRIPTION J33 TURBINE ENGINE

R E S T R I C T E D

A L L I S O N

S E R V I C E S C H O O L T R A I N I N G M A N U A L

for the

A L L I S O N J 3 3 T U R B I N E E N G I N E

Compiled by Allison Service School

S E C T I O N 1

I N T R O D U C T I O N

This manual is issued for the information and guidance of those attending the Service School conducted by the Allison Division of General Motors Corporation. Information contained herein is considered necessary to those who are, or will be, concerned with servicing the Allison-Built J33 Turbine Engine, and should be retained for future reference. Instructions given are the result of preliminary experience in design, development, manufacture and service operations on the engines and the service instructions outlined should be followed closely.

This section is to be devoted to an introduction of Jet Propulsion in general. The ideas presented in Section 1 can be applied to any Jet Propulsion Turbine Engine unless a certain engine is specified.

The remaining sections will contain information concerning the J33 Engine only, and will tend to familiarize the personnel reading it with every phase necessary in servicing the engine.

A Jet Propulsion engine, as defined by engineers, is any form of a reaction engine which develops its forward thrust by the rearward emission or discharge of a jet of any gas or liquid.

The following illustrations indicate simple examples of jet propulsion:

Examples -

A released inflated balloon (Fig. 1-a)

A 4th of July skyrocket (Fig. 1-b)

A common lawn sprinkler (Fig. 1-c)

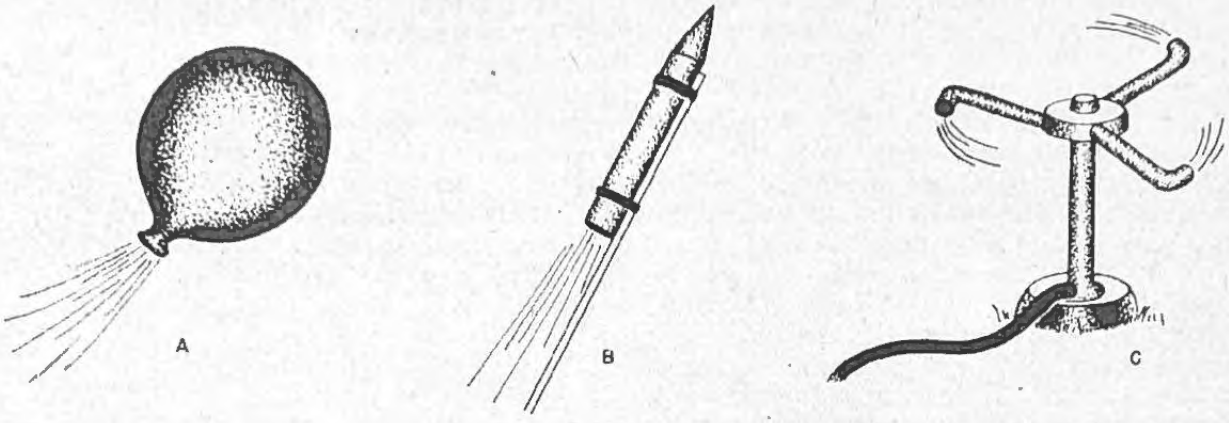


FIG. 1

The three illustrations in Fig. 1 demonstrate in principle, Newton's Third Law "for every action there is an equal, and opposite reaction."

It must be remembered that all three of the jet propulsion engines, illustrated in Fig. 1, receive their forward movement by one means, and that is the rearward emission of gas or liquid.

That this may not be misinterpreted, it is well to note that it is not the gas, or liquid, pushing against the air outside that drives these engines, but only the reaction from the action of the emission of the jet.

To further illustrate this point, Fig. 2, a and b, indicate a dumbbell type of engine under air pressure.

The dumbbell shown in Fig. 2-a, has no opening that permits the air to flow, so there is no action, and consequently, no reaction.

The dumbbell shown in Fig. 2-b, has an opening in each ball, on opposite sides, permitting a jet of air to escape, and this flow of air is the action, creating a reaction on the engine, causing a turning movement on its axis in the direction indicated.

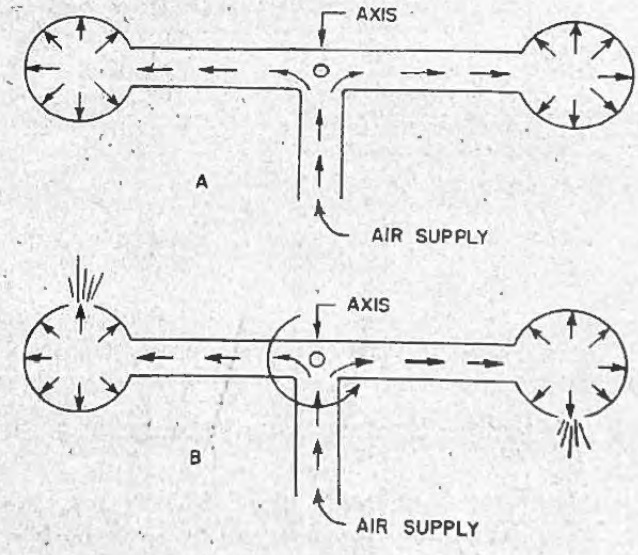


FIG. 2

It is also to be remembered that the outside air (atmosphere), is a restriction to the jet rushing out, and has considerable effect on the efficiency of the action. This atmosphere likewise hinders the forward movement of the engine. These factors cannot be ignored and are dealt with under a THRUST formula, but in passing, we note that the forward movement of the engines illustrated would be more rapid if their travel could be accomplished in a vacuum, since they are self-sustained units.

A rocket is a form of jet propulsion (Fig. 3-a). However, it is to be remembered that the rocket carries all the necessary ingredients or materials, in some form on board, so that it is not dependent upon the surrounding atmosphere for oxygen to support the combustion, which is necessary to create the high velocity discharge at the jet.

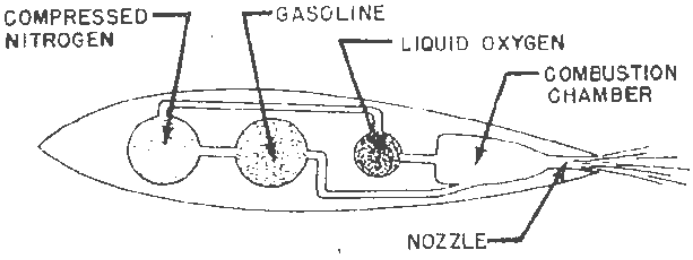


FIG. 3-a

A thermal jet engine (Fig. 3-b), on the other hand, is dependent upon the surrounding atmosphere for the oxygen necessary for combustion. It will operate in the stratosphere, but it can not function in the regions where there is no air. Therefore, the magnitude of the thermal jet's thrust, somewhat like the normal reciprocating engine plus propeller, falls off with the increased altitude, unlike the rocket which maintains relatively constant thrust with increasing altitude, (Fig. 4).

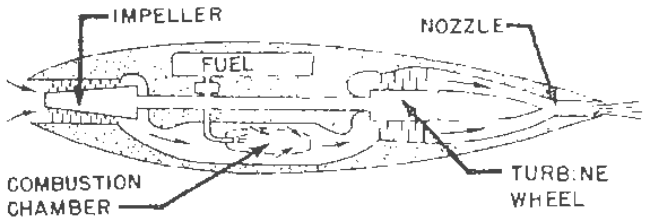


FIG. 3-b

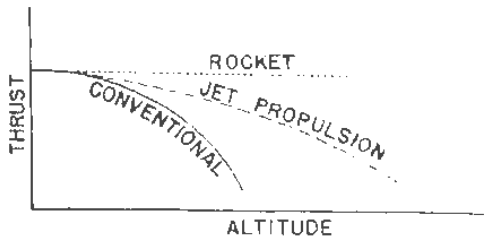
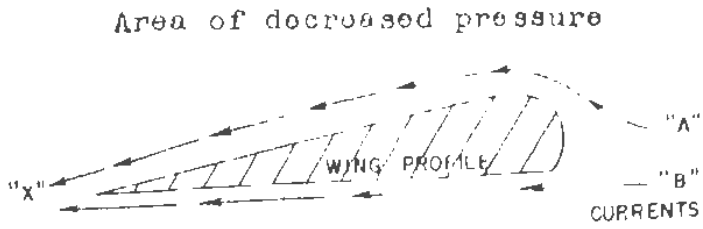


FIG. 4

The thermal jet engine is really a simple machine similar to the turbo-supercharger, as we know it. The turbo uses waste gas to drive the turbine, which in turn drives the impeller (compressor), while in the thermal jet engine, the gases are not wasted but deliberately created to drive the turbine and impeller, and then are discharged through the tail pipe and jet to give the desired THRUST. (Fig. 3-b).

The Air Forces decided on Jet Propulsion, when it was realized that the aircraft with the conventional reciprocating engine and propeller combination, seemed to have been developed to the point of propeller limitations. This limit was imposed, by the falling off of the propeller efficiency when effects of compressibility set in at the higher speeds desired.

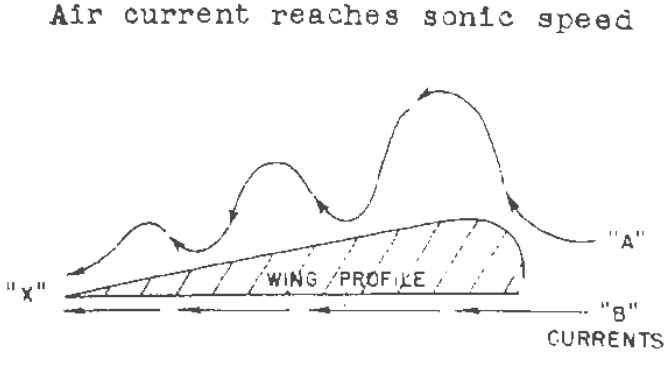
The phenomenon called COMPRESSIBILITY is sometimes called "COMPRESSIBILITY BURBLES" in that the slip stream, or stream-lined flow pattern of the air breaks down, thus increasing drag on all airfoils. (Fig. 5-b). Compressibility is linked with the speed of sound (SONIC SPEED) of 763 MPH at 59°F. and varies directly as the absolute temperature varies. Therefore, with an increase in altitude, there is an accompanying drop in temperature and the speed of sound is correspondingly lower, giving a lower limit where compressibility would begin. This does not mean that the plane must move at that rate of speed, because there is always a LOCAL INCREASE in the speed of the air over an airfoil in motion.



A WING PRODUCING NORMAL LIFT

FIG. 5 (a)

Air current "A" is speeded up going over the top of the wing more than current "B", thereby causing a decreased pressure above the wing, allowing lift. Air in both currents tend to reach "X" at the same time.



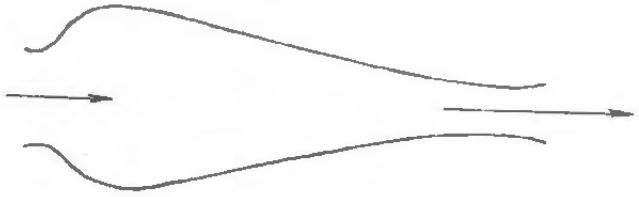
A WING PRODUCING BURBLES

FIG. 5 (b)

Burbles are caused by the exceedingly high speed at which the wing is traveling. This causes the upper current "A" to have an increase in speed that gives a velocity greater than the speed of sound. When it must decelerate to meet current "B" at "X", burbles are formed.

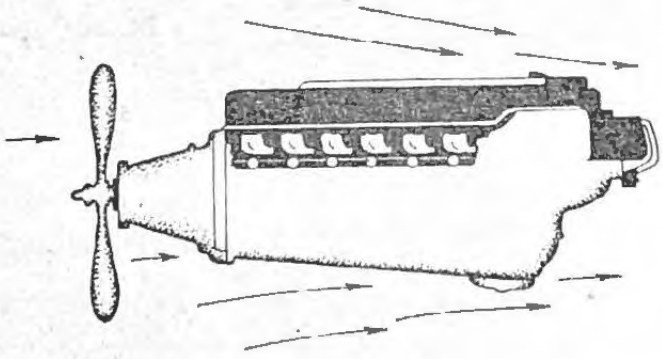
Because of its rotational speed, as well as its forward speed, the propeller is affected before the wings, etc.

Broadly speaking, the reciprocating engine-propeller combination and the jet propulsion engine power plant are similar. Each gains its thrust by changing the momentum of the air, giving THRUST which is the product of MASS (weight) times INCREASED VELOCITY. (Fig. 6).



The thrust gained by the thermal jet engine.

FIG. 6



The thrust gained from a conventional engine and propeller combination.

However, the breakdown of the propeller efficiency, even when in combination with efficient reciprocating engine, as compared with the thermal jet, which increases its efficiency with increased forward speed, leaves no doubt that the jet propulsion scheme is the BEST propulsive plant for high speed and high altitude performance. (Fig. 7 and 3).

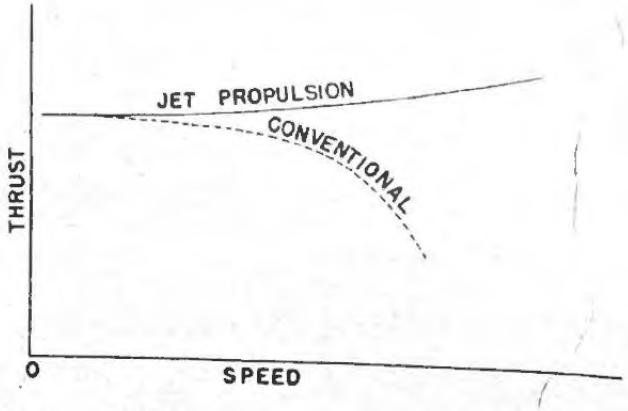


FIG. 7

The development of the J Type Engine, which is basicly a Whittle design, was the direct result of an essay written by Frank Whittle of England in 1930, when as a cadet in the R. A. F. in answer to the question, "What do you imagine might be the most outstanding change in aircraft in the next decade?" His answer was the essay entitled "Jet Propulsion".

The essay aroused great interest in aviation circles and Whittle was selected to pursue his ideas in a University. The government subsidized the building of a bench model and later fostered the construction of a model for flight. On May 11, 1941, Whittle's first jet propulsion aircraft flew successfully.

The U. S. Air Forces, aware of the development in jet propulsion engines, both in England and on the Continent, contracted with the General Electric Company, of Schenectady, New York, to aid in the experimentation. This company was selected because of their considerable experience in building gas turbines. In addition, their affiliated company had assisted in the original development of the Whittle engine in England. The Bell Aircraft Corporation of Buffalo, New York, designed a plane.

The first Whittle engine was brought into this country from England on October 1, 1941. One year was allotted to build the engine to conform to American requirements, and develop an American military aircraft. One year and a few days from that date, the first twin engine, Jet Propulsion, military aircraft (XP-59), was flown at a remote American desert station of the AAF in California.

American experience greatly influenced the design of the present jet propulsion engine. Bevel gearing was changed to the more compact spur type of gearing, the accessory mountings were changed to conform to the U. S. Air Force standards, and the turbine wheel was greatly improved, through General Electric Company's knowledge of metallurgy.

The type J engine, is a new and radically different type of power plant. It is a distinct departure from the conventional aviation engine, in that it is based on different engineering principles. It has a different means of propulsion, and its operation and performance are correspondingly different. Its power, altitude, and speed are outstanding. It has reached greater altitudes, carrying a greater load than any comparable military aircraft, and requires no supercharger. In addition, it has an almost instantaneous take-off, requiring only a fraction of a minute to warm-up. Having no propeller and only one major moving part, it is practically vibrationless. It is lighter in weight, more simple in construction and operation, in that it has fewer gauges and controls, and permits the aircraft to have a lower center of gravity (no propeller).

Furthermore, it is a complete aircraft power plant. Being complete in itself, it does not need such accessories as oil coolers, additional superchargers, intercoolers, nor the controls necessary for the operation of such devices. It has a simple three point suspension (Fig. 8), in a specially designed compartment in the fuselage, or nacelle, of the airplane.

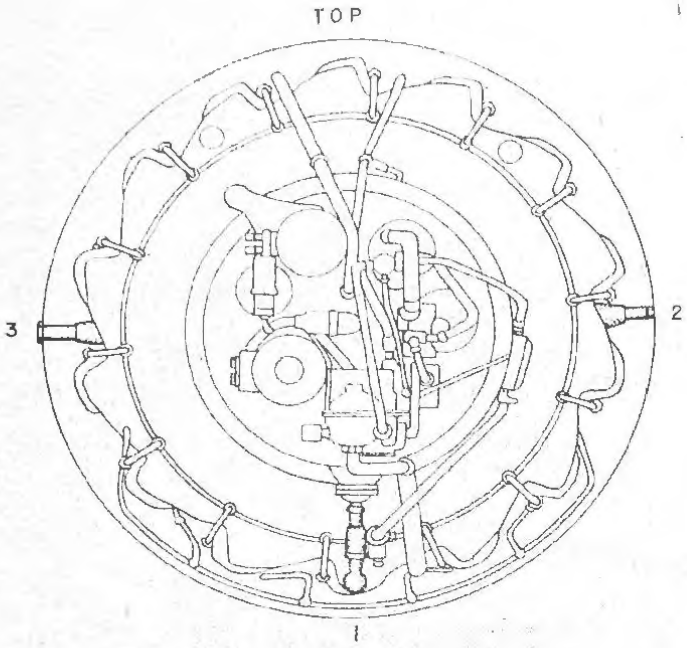


FIG. 8

The chamber around the front of the engine is so designed as to form a duct, through which rammed air is supplied to the compressor (Fig. 3-b) in flight. Connected to the exhaust cone, at the rear of the unit, is a tail pipe and jet nozzle that provides for the escape of the exhaust gases. The only other connections required, are for fuel, electricity, and the five instruments.

The jet propulsion engine, is an internal combustion turbine engine, that develops its thrust by the emission of gas through the jet nozzle which is attached to the rear of the engine, at a higher velocity than the velocity of the air at the intake. The amount of thrust is dependent upon the MASS of the air times its INCREASED VELOCITY; or thrust = mass x increased velocity.

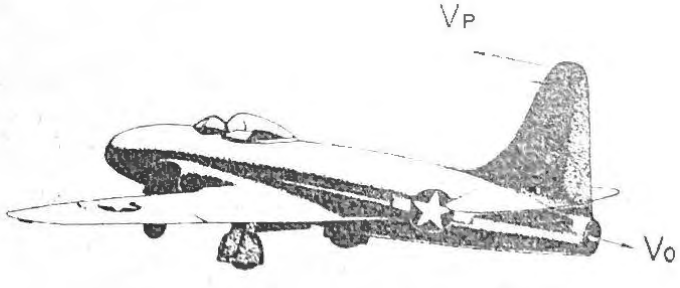
The subject of jet propulsion, to be more clearly understood in the Type J 33, can be broken down into three phases:

1. Air for MASS (part of which is used for COMBUSTION) is taken on board the engine. (The taking of air aboard and accelerating it to the velocity of the plane, results in additional drag upon the plane).

2. The air must be processed on board (heated and expanded -- putting additional energy into it).

3. The air expanded and ejected (discharged) rearward in the form of a jet.

After the air has completed this cycle and is ejected rearward at the jet, potential thrust is obtained. There is THRUST when the velocity of the air ejected in relation to the plane EXCEEDS the velocity of the plane in relation to the surrounding atmosphere.



V_o= Velocity of jet in relation to the plane

V_p= Velocity of the plane in relation to the atmosphere

FIG. 9

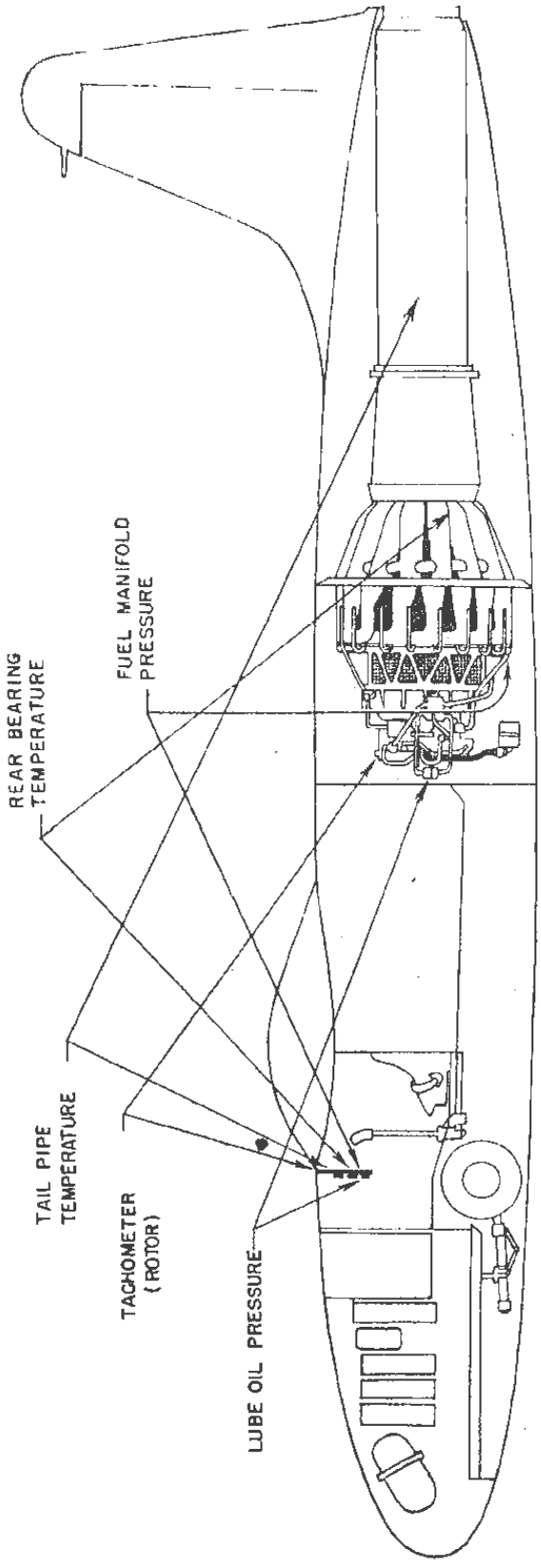

REAR BEARING TEMPERATURE
FUEL MANIFOLD PRESSURE
TAIL PIPE TEMPERATURE
TACHOMETER (ROTOR)
LUBE OIL PRESSURE

FIG. 10

From the formula above, it follows that thrust will increase if the jet velocity is increased, or if the MASS flow of air is increased. Therefore, as forward velocity is increased, the additional ramming of the air increased the MASS flow, thereby giving more thrust.

Therefore, the Type J 33 jet propulsion engine, is a mechanical device, which develops its thrust by imparting high velocity to large masses of air, through a cycle of compression, combustion, and expansion; and with all other factors remaining equal, the plane's forward speed is the variable that affects thrust most. The greater the forward speed, the greater the available thrust, because of added ram.

Also, the thrust obtained varies inversely as the absolute temperature, which means that under all other similar conditions, the lower the free air temperature, the greater the thrust.

The operation of the J 33 turbine engine is relatively simple compared to that of conventional airplane power plants of high rating. All that is required of the pilot for starting, is to engage an electrical switch, push a starter button, and operate the throttle valve. In less than a minute the airplane is ready for take-off. The number of engine instruments is small compared to that required for the operation of other aviation power plants. At the present time there are only five engine instruments (Fig. 10) to be observed; these record exhaust temperature, burner fuel pressure, lubricating oil pressure, rear bearing temperature, and rotor speed. This simplicity of operation relieves the pilot of considerable attention to the power plant, and gives him more opportunity to attend to his business of combat and flight.

This unit is particularly adaptable to high altitude flight, in as much as it is both a gas turbine aviation engine and a turbo-supercharger in a single unit, with all the speed and altitude which the alliance of these two power-producing agents make possible. The conventionally designed aviation engine loses its efficiency as it climbs to altitude because of the gradually decreasing density of the air to both the engine and the propeller. Hence, to restore to the engine an air density approximating sea-level, it must be equipped with a supercharger or turbo-supercharger, to compress the rarefied air of the atmosphere for efficient operation. The propeller, however, still has to cope with the rarefied air. The J 33 turbine engine, on the other hand, climbs to altitude under its own power without requiring any additional power-increasing devices. It has no propeller problem. And since air resistance and air temperature are reduced at high altitudes, greater speed and efficiency of high altitude flying are made possible.

The following definitions are used throughout this and subsequent Type J 33 Allison publications: (Fig. 11)

FRONT -

The accessories and (generator, starter, pumps, etc.), is to be considered the front end.

REAR -

The opposite of front or the exhaust cone end, is to be considered the rear end.

LEFT AND RIGHT -

The terms left and right are established when standing at the rear end, facing the front - then those component parts on the left or right side, are so designated.

ROTATION -

The major rotating part is the rotor assembly (impeller and turbine), which rotates left-hand or counter-clockwise, as established by standing at the rear of the engine, facing the front.

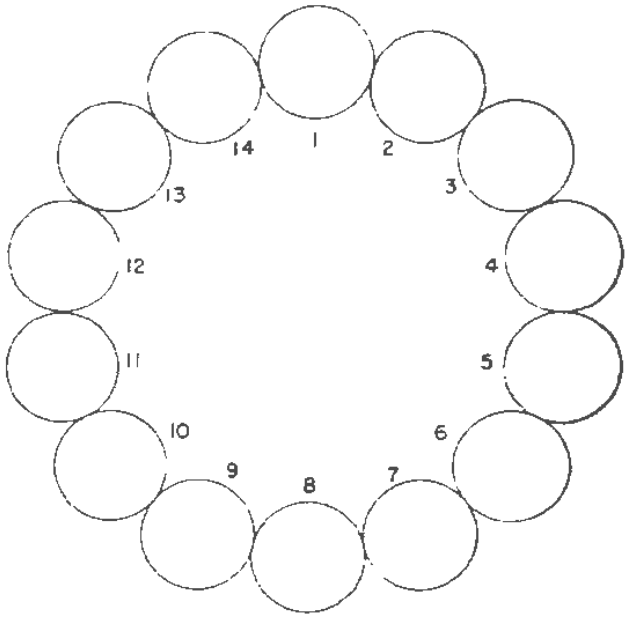
ACCESSORIES ROTATION -

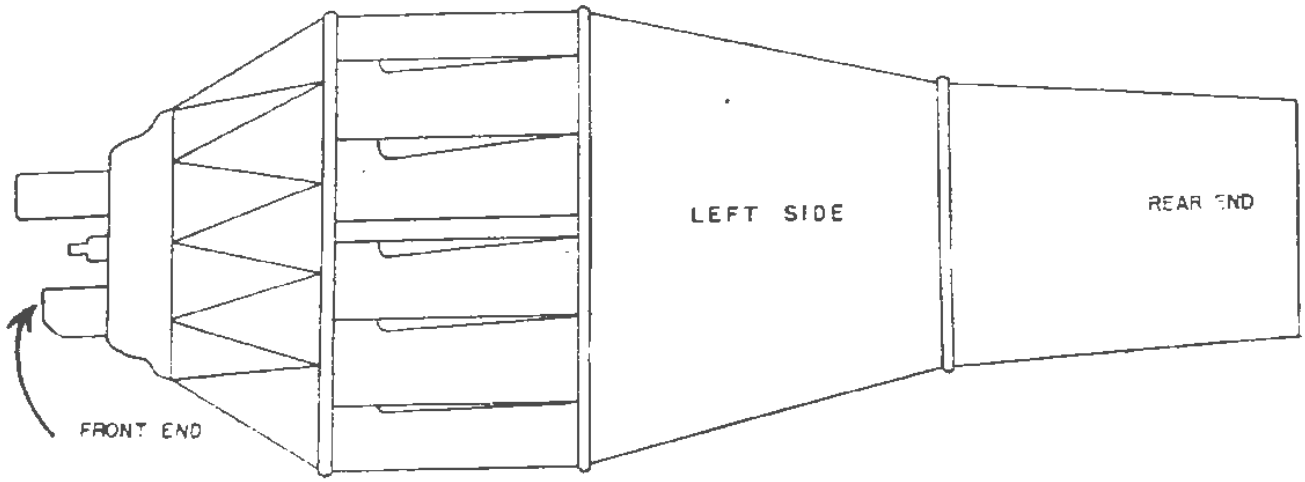
Accessory drive rotation, is termed left (counter-clockwise), or right (clockwise), as viewed from the front end of engine, or facing the mounting pads.

COMBUSTION CHAMBER SEQUENCE -

Combustion chambers are numbered as viewed from the rear end of the engine as follows:

No. 1 is directly at the top or the center of the engine and the next chamber going to the right is No. 2. The next is No. 3 and so on until No. 14 is reached which will be immediately to the left of No. 1.





The Type J33 engine is designed in such a manner that it can be disassembled into four main sub-assemblies. Each of these can be further broken down into other sub-assemblies. For the purpose of simplicity, the four main sub-assemblies will be designated as "ASSEMBLIES" and the minor sub-assemblies will be designated as "SUB-ASSEMBLIES" (Fig. 12).

The main assemblies are:

1. Accessories and accessories gear casing (includes casing, gears, accessories).

2. Compressor unit (includes compressor casing, impeller, truss rings, diffuser, front and rear bearing supports, and guide vanes).

3. Turbine unit (includes turbine wheel, housing, bearing support, ring and tube assembly, flame tubes, and adapters.

4. Exhaust cone (includes inner and outer cone and directional fins).

In the ensuing text, frequent reference is made to the Table of Limits, Section 5. This table shall be regarded as the indispensable guide throughout the operations which involve measurement, or the use of gauges. It contains a tolerance limit required in balancing the impeller and rotor and the various clearances that must be taken during dismantling, disassembly, and assembly of the unit. It also lists the amount of torque allowable on the nuts of the impeller and tail cone.

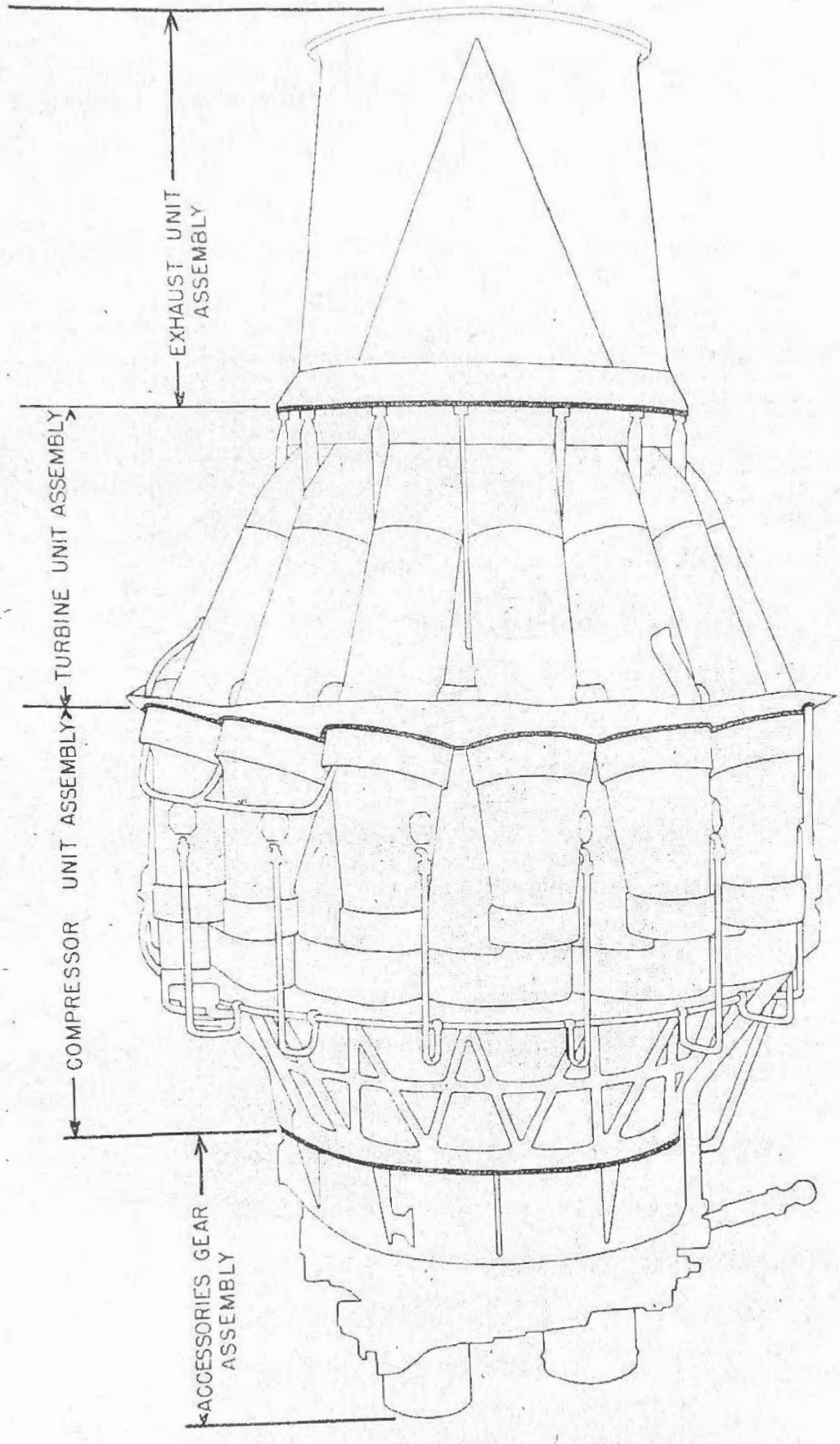

EXHAUST UNIT ASSEMBLY
TURBINE UNIT ASSEMBLY
COMPRESSOR UNIT ASSEMBLY
ACCESSORIES GEAR ASSEMBLY

FIG. 12

RESTRICTED

INDEX TO SECTION 2

DESCRIPTION J 33 TURBINE ENGINE

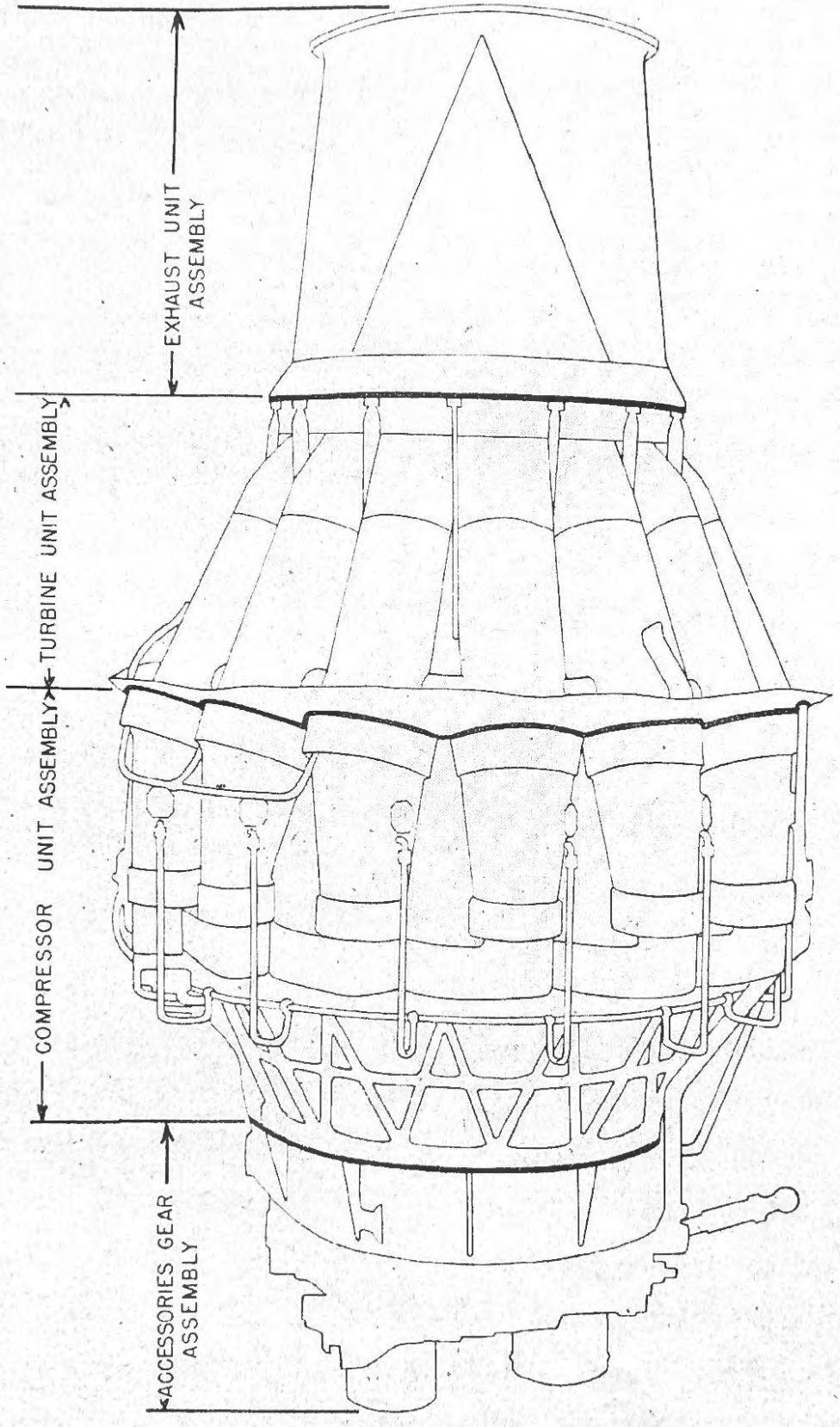
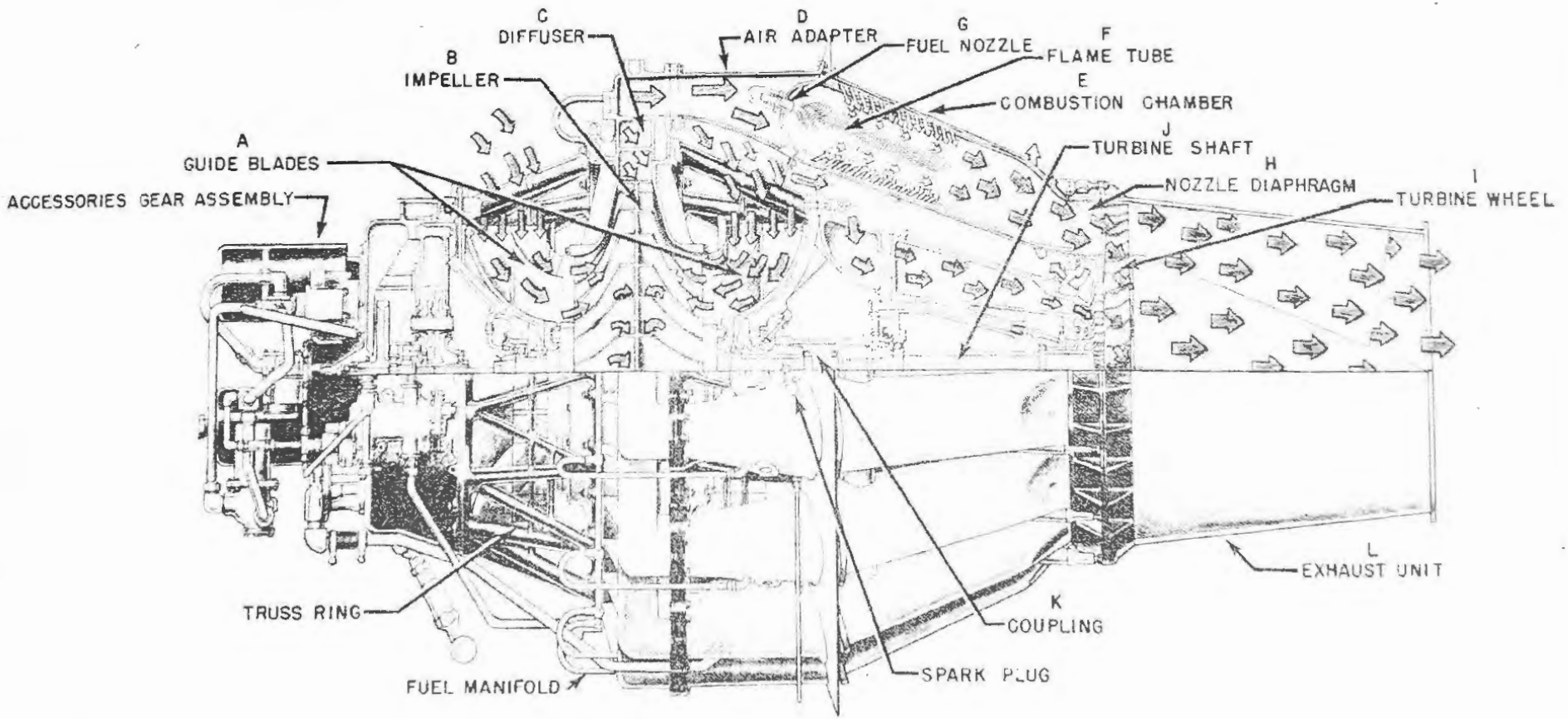

EXHAUST UNIT ASSEMBLY
TURBINE UNIT ASSEMBLY
COMPRESSOR UNIT ASSEMBLY
ACCESSORIES GEAR ASSEMBLY

FIG. 12

INDEX TO SECTION 2 (Cont'd.)

DESCRIPTION J33 TURBINE ENGINE

AIR FLOW AND COMBUSTION
J33 GENERAL ELECTRIC TURBINE ENGINE



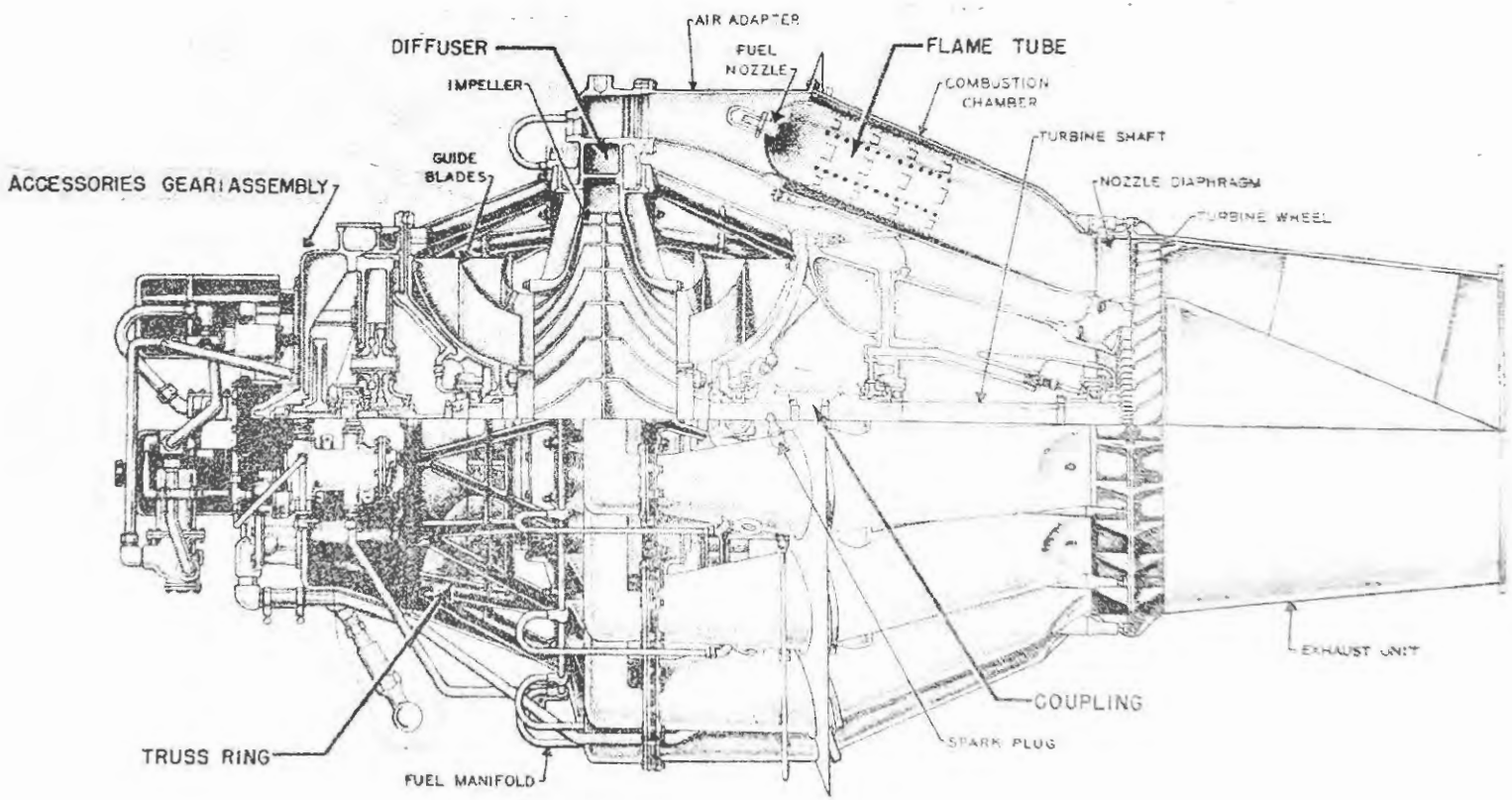
INLET AIR — COMPRESSED AIR — FUEL AIR MIXTURE — FUEL

COMBUSTION — EXHAUST AIR — COOLING AIR EXHAUST

Allison XA-1 SERVICE DEPT 2-18-45

FIGURE 1

NOMENCLATURE
J33 GENERAL ELECTRIC TURBINE ENGINE



Allison XE-1 TURNED OVER
2-21-45

FIGURE 2

S E C T I O N 2

D E S C R I P T I O N J 33 T U R B I N E E N G I N E

1. GENERAL DESCRIPTION:

The type J33 engine is a mechanical device which develops its thrust by imparting high velocities to large masses of air through a cycle of compression, combustion, and exhaust. It is an aircraft internal combustion turbine engine. Its only major moving part is the rotor. This is mounted on anti-friction bearings and consists of a centrifugal air compressor connected by a composite shaft to a single stage turbine wheel. The rotor is motivated by the gas expanded by the combustion of liquid hydrocarbon striking the wheel at high velocity. The combustion of fuel takes place in a series of fourteen combustion chambers which receive fuel through individual burner nozzles from the fuel system. Air for maintaining combustion is introduced to the combustion chambers from the compressor.

Atmospheric air enters at the front of the engine at "A", (Fig.1), through guide blades located at the front and the rear of the centrifugal impeller "B".

The guide blades direct the air into the curving channels of this rapidly revolving double-sided impeller, which scoops up the air, and discharges it at a high velocity into the centrifugally designed diffuser channels "C" of the compressor casing. These channels slow the velocity of the air and distribute it evenly through the fourteen air adapters "D" into the fourteen combustion chambers "E". When the air reaches the combustion chambers, it enters the flame tubes "F", through a series of holes in the flame tube, and mixes with the fuel from nozzles "G" for combustion. The resulting gas expands instantaneously and forcefully, and is directed from the flame tubes through the curved blades of the nozzle diaphragm "H" against the turbine wheel "I", causing it to rotate. The energy of this gas passing through the turbine wheel turns the shaft "J", which being connected by the coupling "K" to the impeller shaft, furnishes the motive power for the impeller "B". The gas, after passing through the turbine, then escapes into the exhaust unit "L" and exhaust pipe and nozzle, creating thrust for propulsion. Hence, a complete mechanical cycle is accomplished, since the air coming into the compressor mixes with the burning fuel for combustion, and the resulting gas turns the turbine wheel which turns the impeller that brings in more air to repeat the process in a continuous operation.

The thrust, created by the gas discharged through the exhaust cone and tail pipe nozzle, impels the airplane forward through the air by means of jet propulsion. Jet propulsion in aviation is the motive power whereby an airplane moves through space by means of gas ejected in jet form from the rear, creating the thrust of propulsion. Thrust exists when the jet velocity, in relation to the plane, exceeds the velocity of the plane in relation to the atmosphere. Therefore, thrust increases as the jet velocity is increased, and as mass air flow is increased. Both are controlled by the amount of fuel burned.

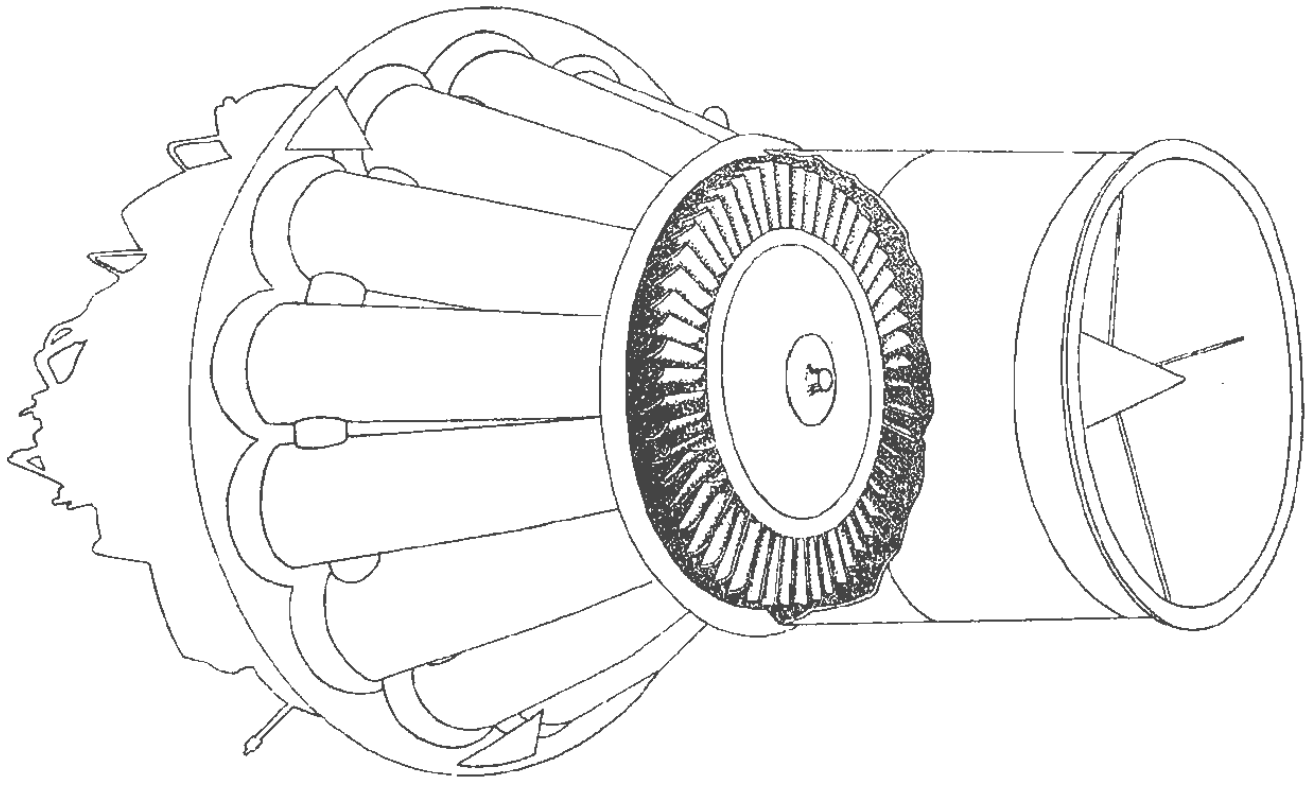
The more fuel that is burned, the greater is the thrust of propulsion and therefore, the faster the plane moves through the air. Since burning is continuous, as long as the fuel flows, the airplane moves through the air in a smooth and continuous progression. Because of this continuous flow of air into the unit and of gases out of the unit, the movement of the airplane is an uninterrupted, smooth and sustained advance through the air.

2. DETAILED DESCRIPTION:

The type J33 jet propulsion gas turbine engine consists of:

a. GAS TURBINE

It is a single stage gas turbine, made up of a nozzle diaphragm, a turbine wheel, and a shaft. The diaphragm, constructed of high grade heat-resisting steel, has a series of curved blades, designed to direct the gas against the buckets of the wheel. The low alloy steel shaft is flash welded to the heat-resistant steel wheel; the assembly is then heat treated to relieve strains. Securely dove-tailed into the rim of the wheel, is a continuous circle of curved blades called buckets. The wheel and shaft rotate when the gas, directed by the diaphragm, strikes the buckets of the wheel. After the gas passes through the bucket wheel, it is discharged out of the unit through the exhaust cone.

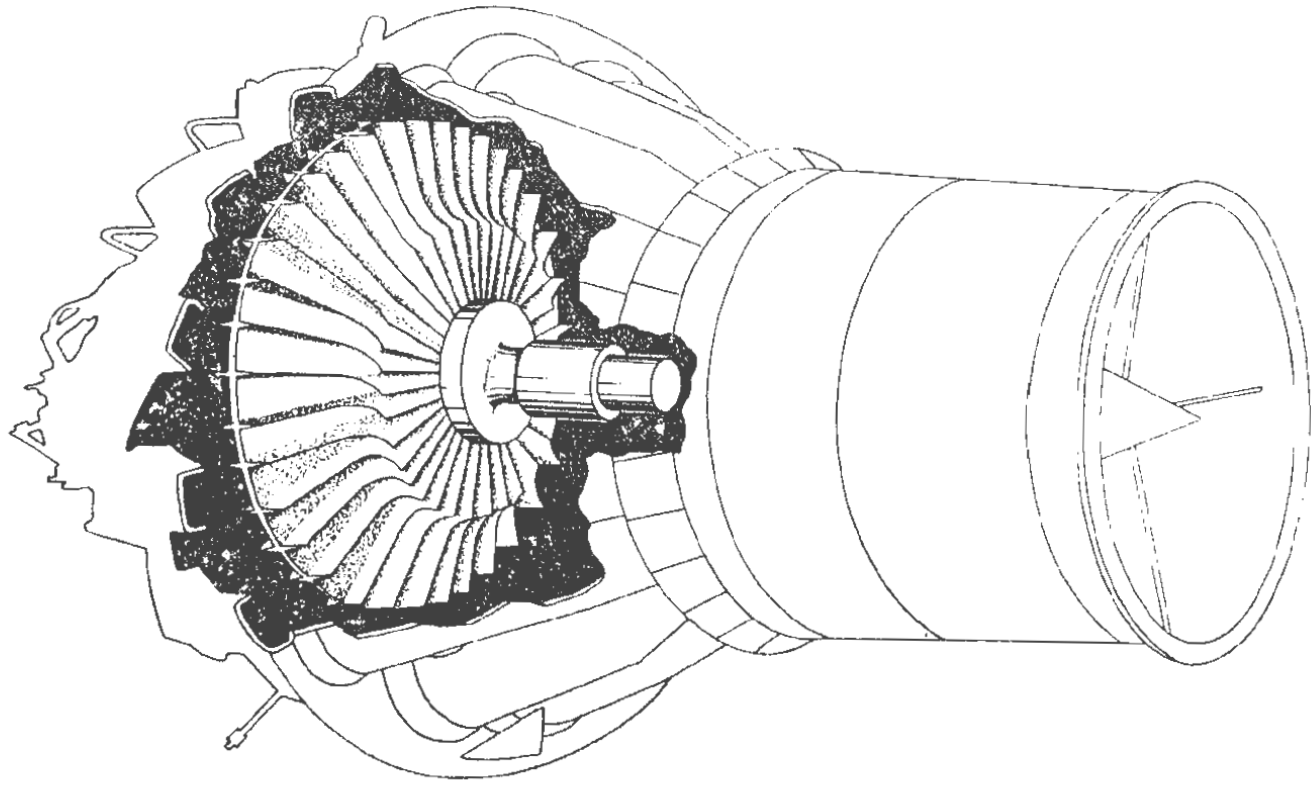


CUTAWAY OF PHANTOM ENGINE SHOWING TURBINE

FIG. 3

b. CENTRIFUGAL AIR COMPRESSOR

A double sided multiple-vaned wheel known as the impeller, enclosed in a casing, together with a diffuser, comprise the centrifugal air compressor. The impeller is a heat treated aluminum forging, capable of withstanding the high speeds at which it must revolve. The curves of its vanes are designed to admit high velocity air with a minimum of shock. The compressor casing, of three parts, is made of magnesium alloy in some models and aluminum alloy in others. The two halves are bolted to the front and rear of the diffuser, through which the air is efficiently distributed into the fourteen elbow openings of the diffuser. The two halves of the compressor casing, when bolted to the diffuser, enclose the impeller.

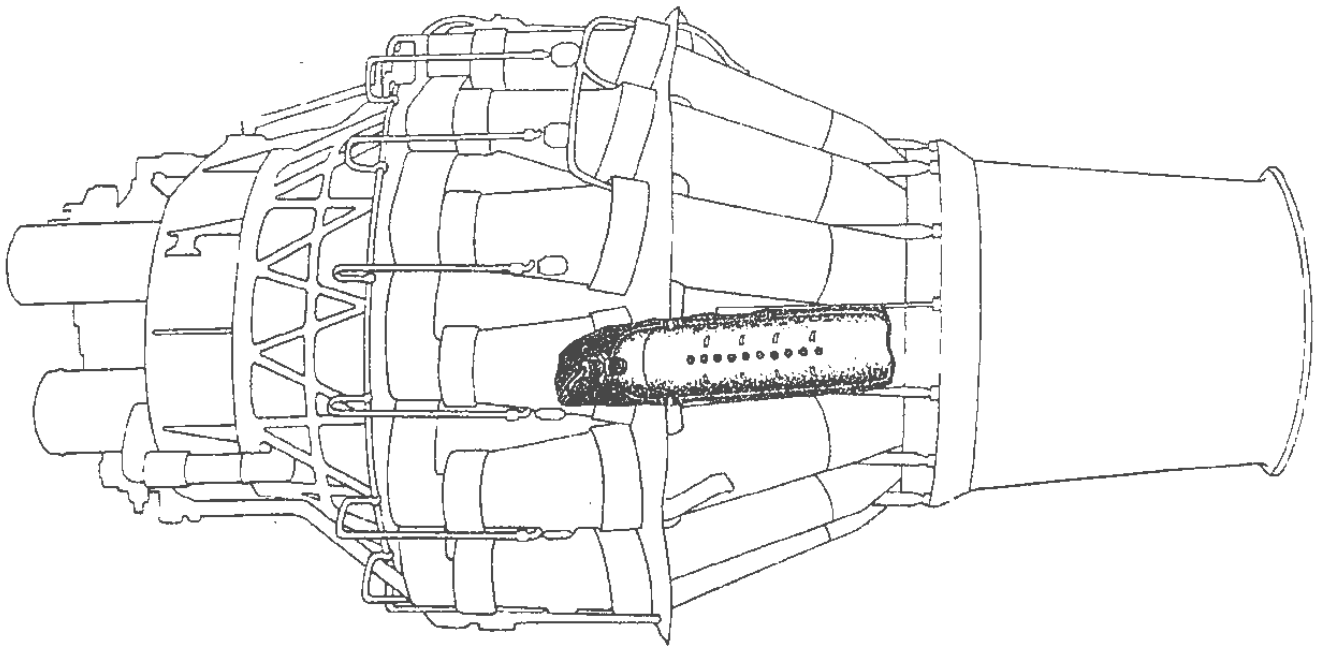


CUTAWAY OF PHANTOM ENGINE SHOWING COMPRESSOR

FIG. 4

c. COMBUSTION CHAMBER

In the fourteen combustion chambers, the air from the compressor is mixed with the burning fuel to cause combustion. Each combustion chamber consists of an outer casing and flame tube. The fourteen outer casings are welded into the ring that surrounds the nozzle diaphragm, forming a complete unit, designated as the ring and tube assembly. The flame tubes are removable, and are made of a high heat-resisting metal. The outer casings are linked together by short connecting tubes, into which inner crossover pipes are inserted, linking the flame tubes together. The fourteen combustion chambers are connected to the fourteen elbow openings of the diffuser by diverging adapters, which contain the domes that seal the forward end of the flame tubes. These domes each have a fuel nozzle mounted in their center, through which fuel is introduced into the flame tubes. The air from the compressor is directed from the fourteen centrifugally designed elbow outlets of the diffuser through the adapters into the outer casings of the combustion chambers, and it follows the path between the inner and outer casings and is admitted into the flame tube through a series of holes. The burning of the fuel takes place in the flame tubes and should be complete before it passes the nozzle diaphragm and turbine. The fuel is ignited at starting, by two spark plugs, one located in combustion chamber No. 7 and the other in combustion chamber No. 14. Refer to Figure 6 for detailed action within the flame tube.



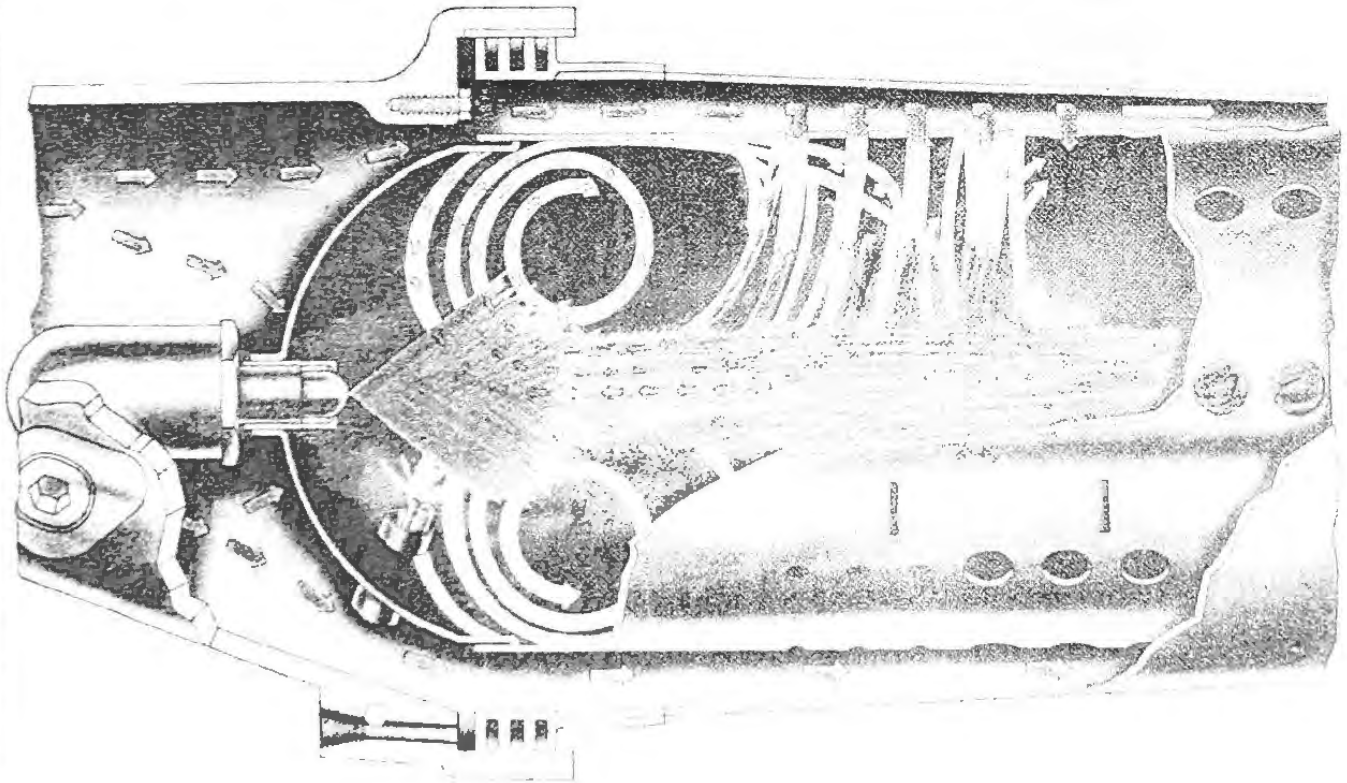
CUTAWAY OF PHANTOM ENGINE SHOWING COMBUSTION CHAMBER

FIG. 5

PRELIMINARY

COMBUSTION CHAMBER DETAILS
J33 GENERAL ELECTRIC TURBINE ENGINE

CUTAWAY SHOWING COMBUSTION IN CHAMBER



END VIEW OF COMBUSTION IN CHAMBER

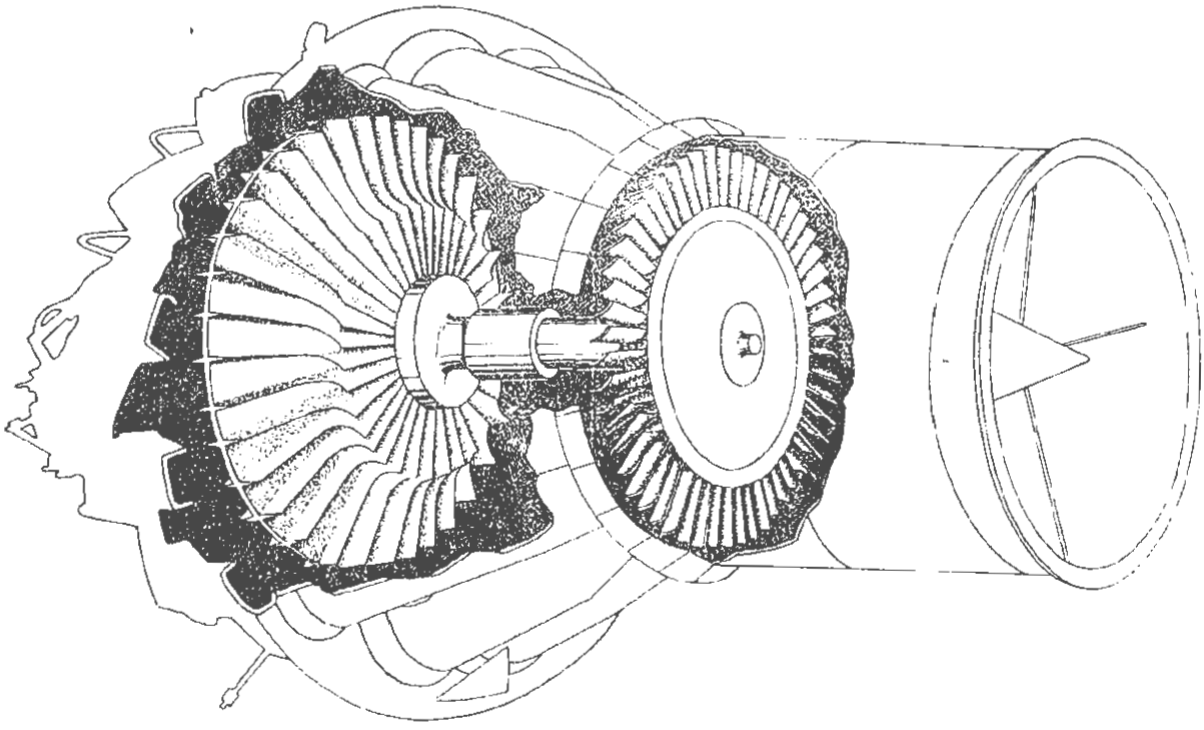
COMPRESSED AIR ◯ FUEL AIR MIXTURE ◯ FUEL ◯ COMBUSTION ◯

XA-2

2-9

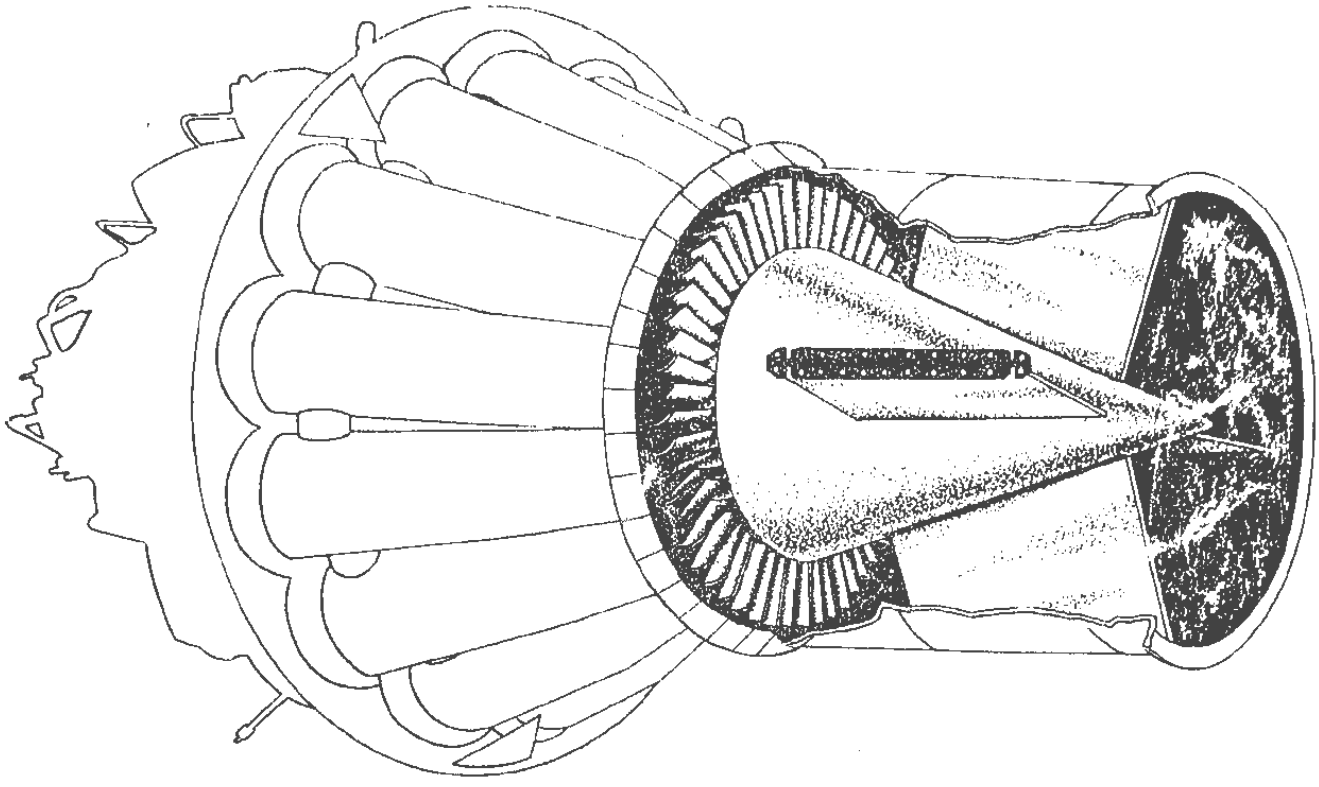
d. ROTOR ASSEMBLY

The rotor is a finely balanced precision assembly and constitutes the heart of the engine. It consists of the turbine wheel with its shaft, and the impeller with its shaft, joined together by a coupling. The entire assembly is mounted on anti-friction bearings. The impeller is supported by a ball bearing on the front shaft, and a roller bearing on the rear shaft. The turbine wheel and shaft are supported by a ball bearing at the front end of the shaft and a roller bearing at the rear of the shaft; both bearings being in front of the turbine wheel. The impeller is housed in the compressor assembly, while the turbine unit contains the turbine wheel shaft and bearings. These two components of the rotor assembly are united during the final assembly by the coupling, splining to the ends of the turbine and impeller shafts. These units are each finely balanced individually, and checked for runout as an assembly.



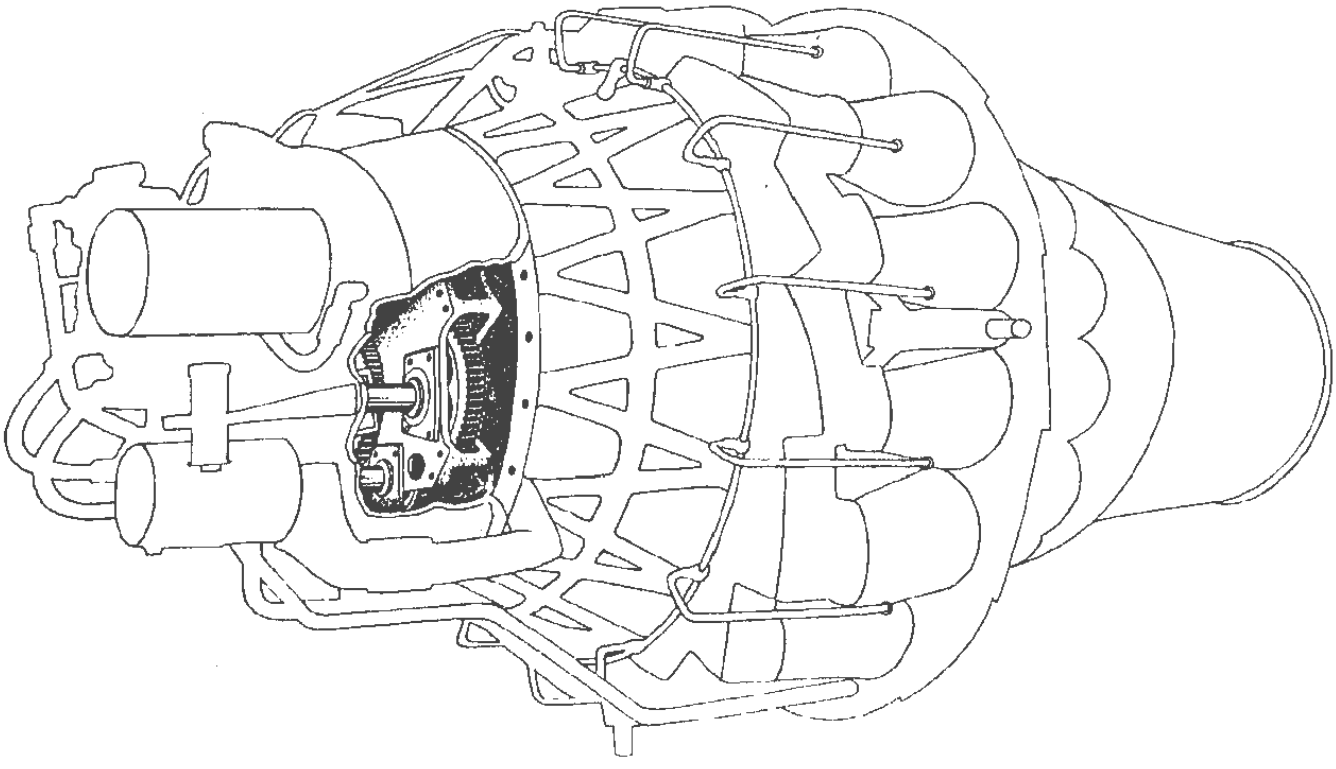
CUTAWAY OF PHANTOM ENGINE SHOWING ROTOR ASSEMBLY

FIG. 7



CUTAWAY OF PHANTOM ENGINE SHOWING EXHAUST CONE

FIG. 8



CUTAWAY OF PHANTOM ENGINE SHOWING REDUCTION GEARS

FIG. 9

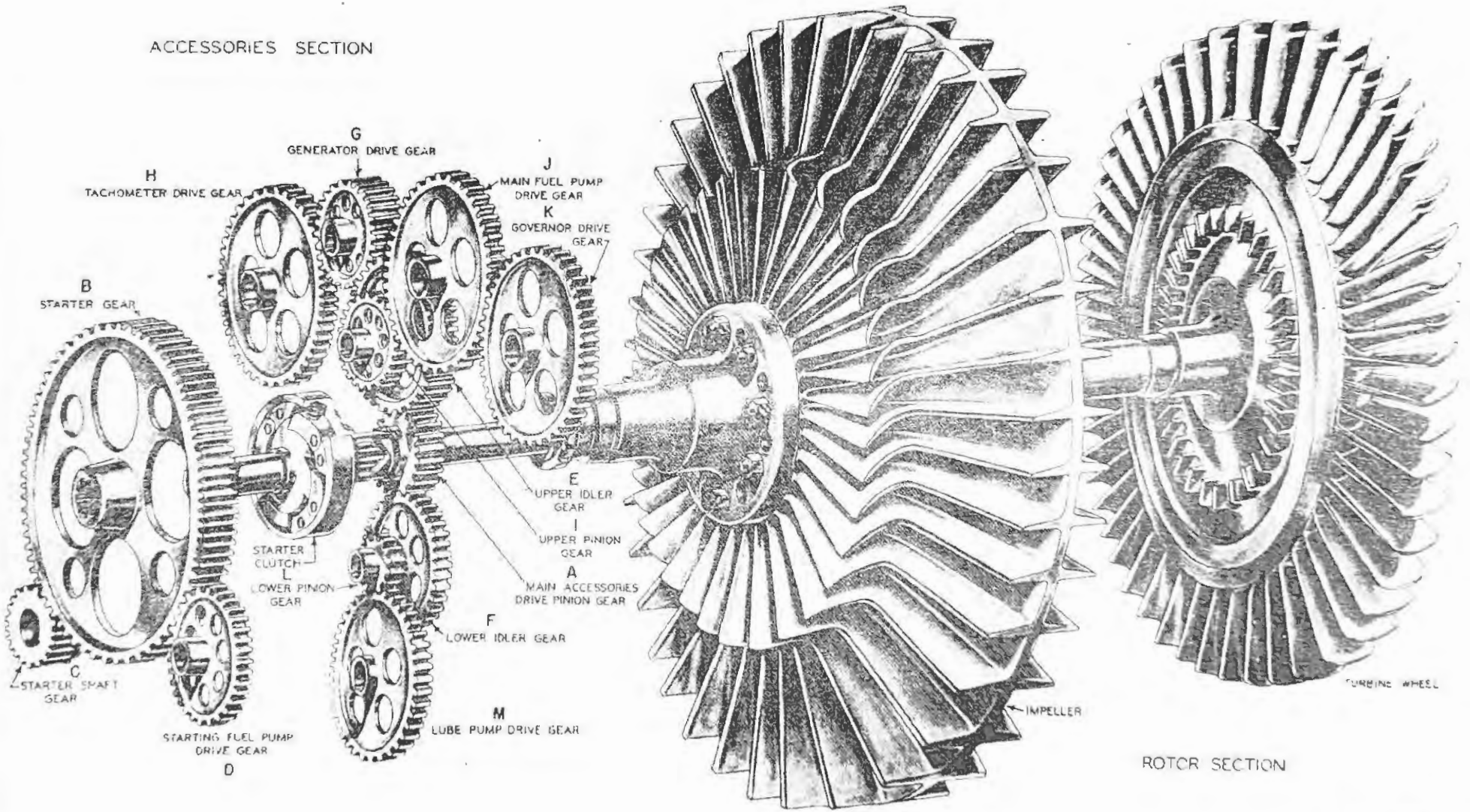
e. EXHAUST CONE

The exhaust cone, bolted to the unit at the rear of the turbine, is a tapered cylinder-shaped outlet for the exhaust gas. It has a closed, smaller cone within it, around which the gas is ejected in a gradually expanding form. The inner cone is supported to the outer cone by four radial streamlined fins or vanes of stainless steel, that assist in straightening out the turbulence of the expanding gas. To prevent excessive loss of heat energy through the exhaust cone, it is covered with four layers of aluminum foil, each separated by a layer of bronze screening.

f. ACCESSORIES GEAR ASSEMBLY

The accessories gear assembly comprised of the gear casing, gear train, and engine accessories, is located at the front of the engine. To easily understand the system of gearing and the relation of one drive to another, refer to Fig. 10. This figure shows the relative location of the gears and the pinions driving them. The main drive pinion "A", which is connected to the rotor by a splined shaft, is connected to the starter gear "B", by a clutch assembly. The clutch disengages centrifugally, when the speed of the rotor reaches a predetermined point. The gear "B" is driven by the gear "C", which is part of the starter. Gear "B" also drives the starting fuel pump gear "D". The pinion "A" drives the intermediate gears "E" and "F". Gear "E" in turn drives the generator gear "G" which drives tachometer generator "H". On the same shaft with gear "E" is a pinion "I", which drives the main fuel pump gear "J", which in turn drives the governor gear "K". The intermediate gear "F" has, on the same shaft, a pinion "L" which drives the lube pump gear "M". Therefore, this accessories gear train driven by the rotor, is composed of a series of reduction gears and pinions, which convert the transmitted speed of the rotor shaft to the rated speed of all accessories, except the starter and starting fuel pump. The starting fuel pump, which is driven by the starter, is only in operation while the starter is functioning, and stops operating when the starter is electrically disconnected.

GEAR TRAIN DIAGRAM
J33 GENERAL ELECTRIC TURBINE ENGINE



Allison XG-1 SERVICE DEPT
4-3-45

FIGURE 10

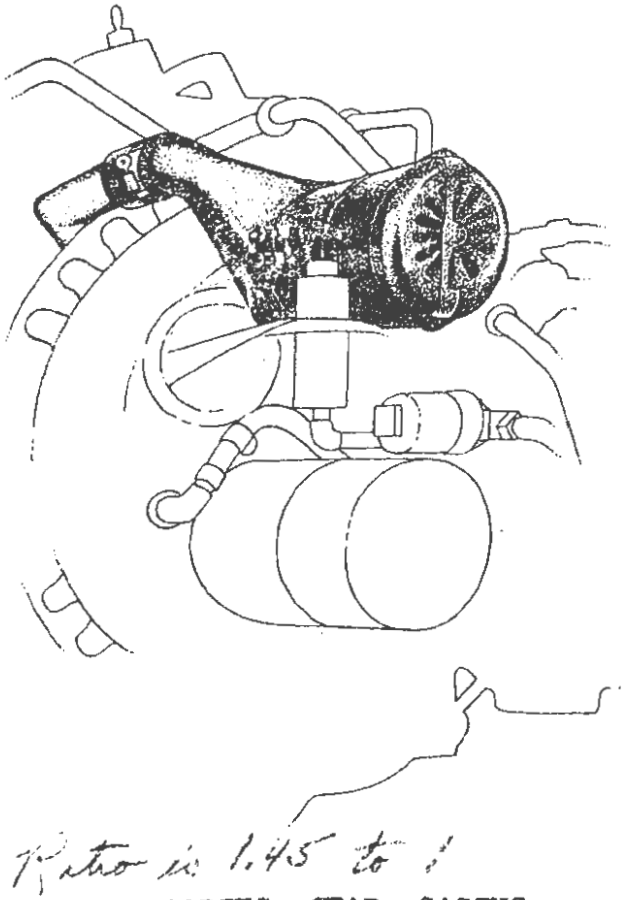
g. ATTACHED ACCESSORIES

(1) GENERATOR

The generator is a six pole direct current generator, with shunt windings of 200 amperes and 30 volts at speeds varying from 4400 to 8000 R.P.M. The generator is mounted on the front of the accessories gear casing, in approximately the "eleven o'clock position, and is cooled by air entering the commutator end and passing through to a discharge manifold and carried to the compressor inlet. The rotation of the generator is clockwise when facing the mounting pad.

(2) STARTER

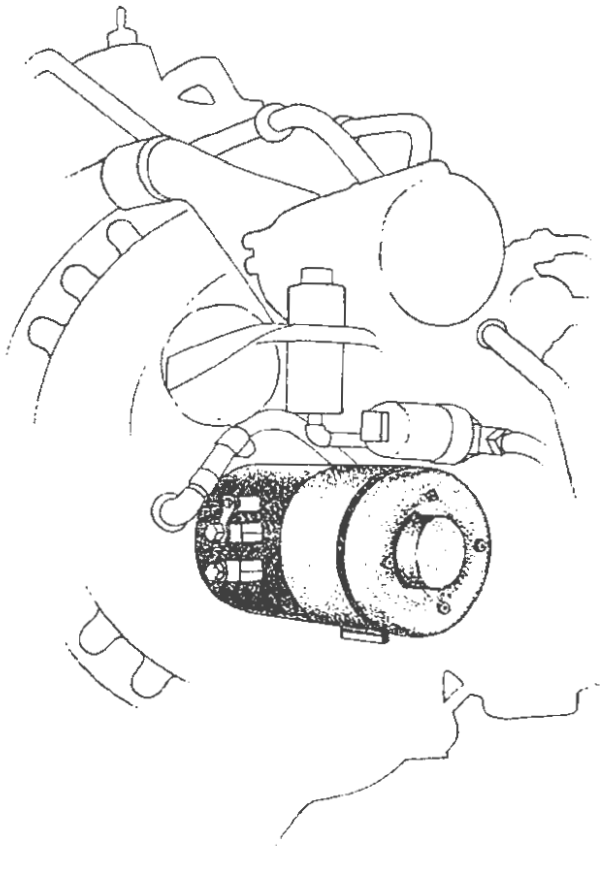
The starter is rated at 17 volts, 300 amperes, at 8000 R.P.M. for INTERMITTENT operation and is mounted on the front of the engine accessories casing, in the "eight o'clock position" and rotates counter-clockwise when facing the mounting pad. The driving end of the starter is geared to the rotor shaft through the starter gear and an over-riding clutch in the accessories gear casing.



Ratio is 1.45 to 1

ACCESSORIES GEAR CASING SHOWING THE GENERATOR

FIG. 11



ACCESSORIES GEAR CASING SHOWING THE STARTER

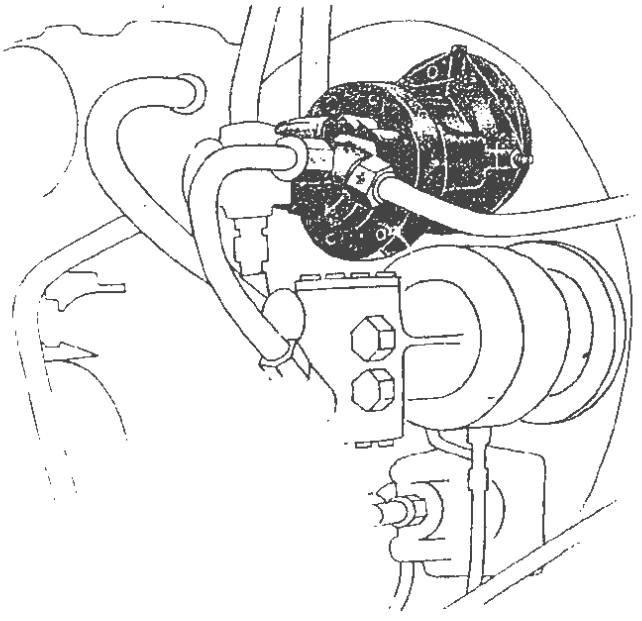
FIG. 12

(3) MAIN FUEL PUMP

The main fuel pump is mounted on the front of the accessories gear casing, in the "one o'clock position", and operates in the clockwise direction facing the mounting pad. It is a pressure loaded, gear-type, positive displacement pump, essentially the same as all standard gear-type pumps designed for aviation hydraulic systems. It has a rated flow of 20 gallons per minute at 3400 R.P.M. and 500 P.S.I. discharge pressure. It is a single element gear pump, with constant displacement at any one speed, and has no relief valve. Fuel enters the intake port, identified by the raised boss on its side containing the spring valve for controlling the "pressure loading" of the internal bushings, and is carried between the tooth spaces around the case and out the discharge port. There are four 1/8" pipe tapped holes in the mounting flange, the lowest one of which is to be piped to an atmospheric drain, that drains out any fuel that escapes past the pump shaft seal, and the three remaining holes are plugged.

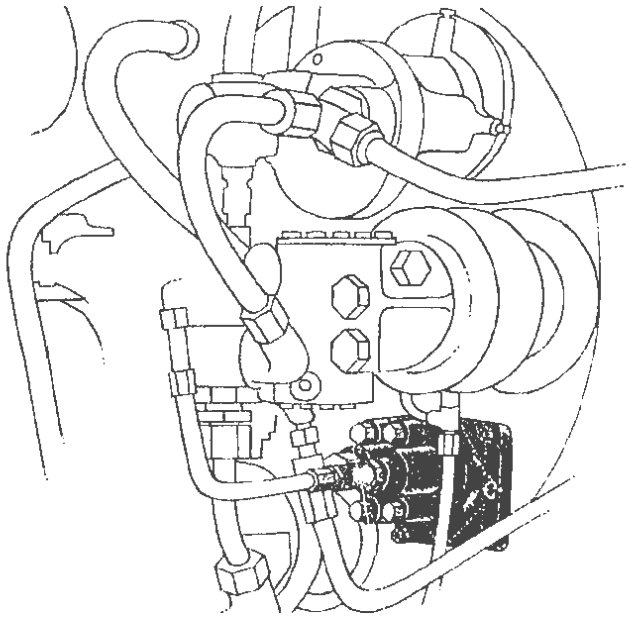
(4) STARTING FUEL PUMP

The starting fuel pump is located on the front of the accessories gear casing, in the "four thirty o'clock position", and is a positive displacement pump of the spur gear type, similar to the main fuel pump, but on a smaller scale. Its rated flow is 4.2 gallons per minute at 5000 R.P.M. and 200 P.S.I. discharge pressure, and its rotation is counter-clockwise facing the mounting pad. The function of the starting fuel pump, which is driven by the starter gear, (Fig.10), is to assist the main fuel pump at the low cranking speeds during the starting of the engine. It is connected in parallel with the main fuel pump and has a check valve attached to the outlet port, which prevents the by-passing of main



ACCESSORIES GEAR CASING SHOWING THE MAIN FUEL PUMP

FIG. 13



ACCESSORIES GEAR CASING SHOWING THE STARTING FUEL PUMP

FIG. 14

pump fuel pressure through the starting fuel pump during normal operation, when the starting pump is inoperative. This pump, has four 1/8" tapped holes in the mounting flange to provide draining of fuel that escapes past the shaft seal. The lowest one of these holes is piped to atmosphere and the other three are plugged.

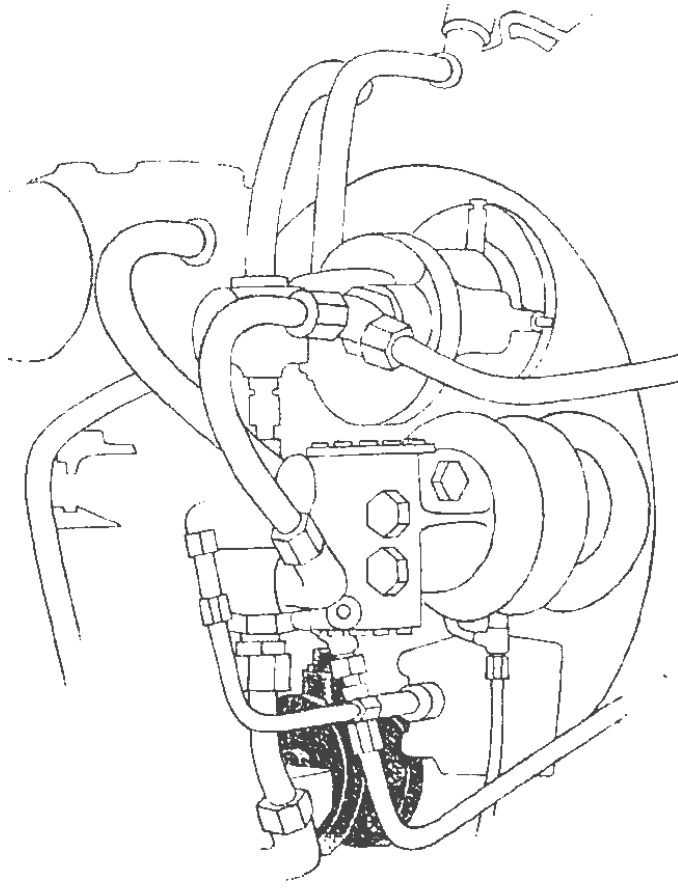
(5) LUBE AND SCAVENGE PUMP

The Nichols Model pump, used for lubrication and oil scavenging, is a two element pressure and suction pump, mounted on the front of the accessories casing, in the "six o'clock position". Its lubricating element is rated to give a flow of three gallons per minute at 2400 R.P.M., and rotates in a clockwise direction facing the mounting pad. The scavenge element is rated at 10 gallons per minute at 2400 R.P.M.

The pumping elements consist of an inner and outer rotor. The inner rotor is concentric with, and driven by the shaft from the mounting pad of the accessories casing. The outer rotor turns in an eccentric steel insert and is driven by the inner element of the driving shaft. The inner rotor has six teeth, and is so designed that each tooth travels over the entire circumference of the outer rotor once every seven revolutions. This results in relatively low rubbing speeds at high shaft speeds. The shaft runs in bronze bearings. As the pump has no unsymmetrical masses it is in balance at all times. (Fig. 16).

The lube element is the one nearest the mounting flange, and is similar in construction to the scavenge element located at the front or the end opposite the lube element and mounting flange end. The inlet port for the lube pumping element is in the machined face of the mounting flange. When the pump is mounted, this port lines up with an oil passage line drilled in the mounting pad of the accessories case.

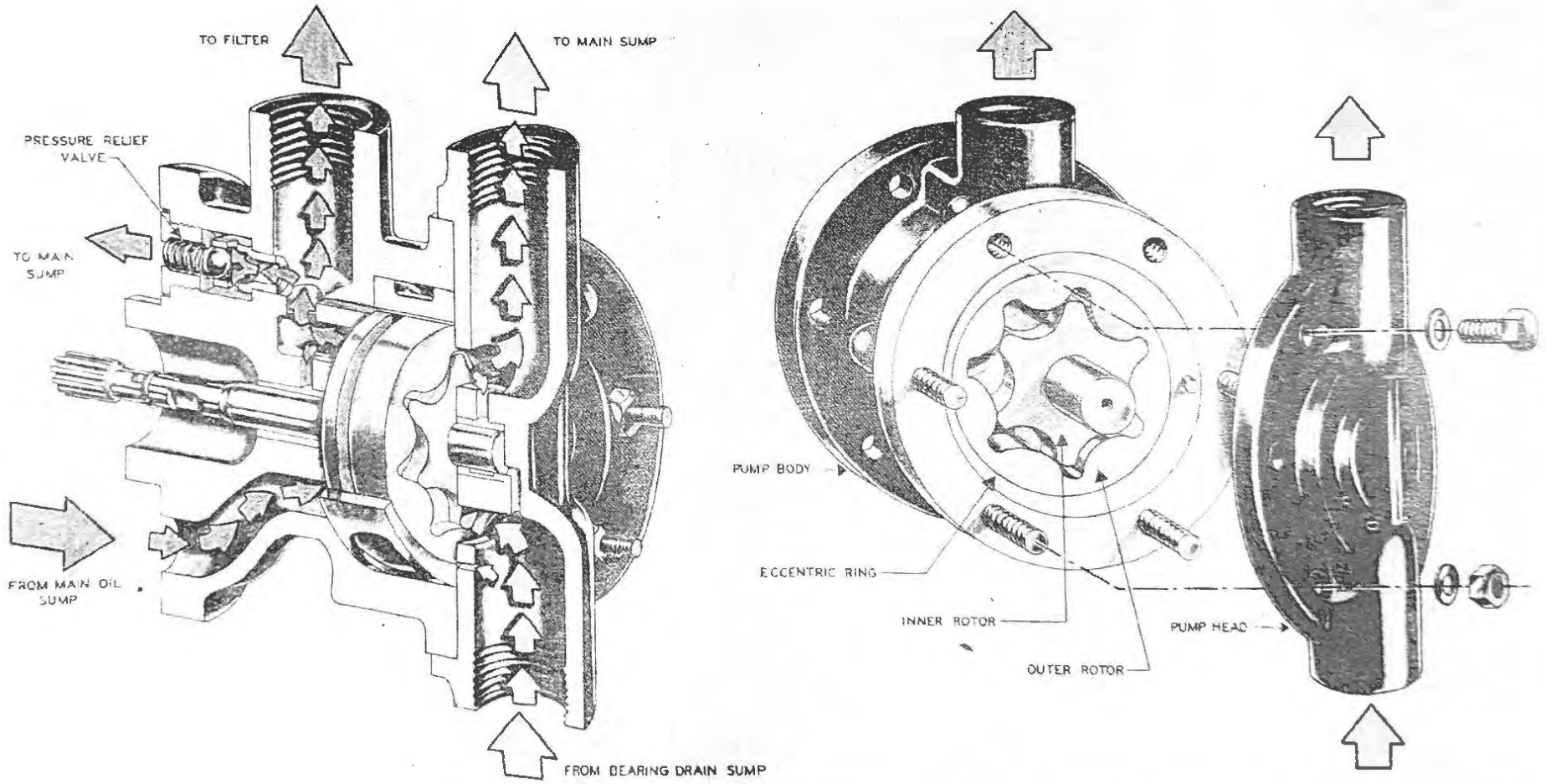
The pump is equipped with a safety valve, which may by-pass oil from the discharge of the lube pumping element, through a port in the mounting flange, directly back into the gear case. This valve is designed to open at 80 to 100 P.S.I. pressure and is not adjustable.



ACCESSORIES GEAR CASING SHOWING THE LUBE PUMP

FIG. 15

LUBE AND SCAVENGE PUMP
J33 GENERAL ELECTRIC TURBINE ENGINE



LUBE OIL SCAVENGE OIL BY-PASS OIL

Allison XT-52 SERVICE DEPT. 3-24-45

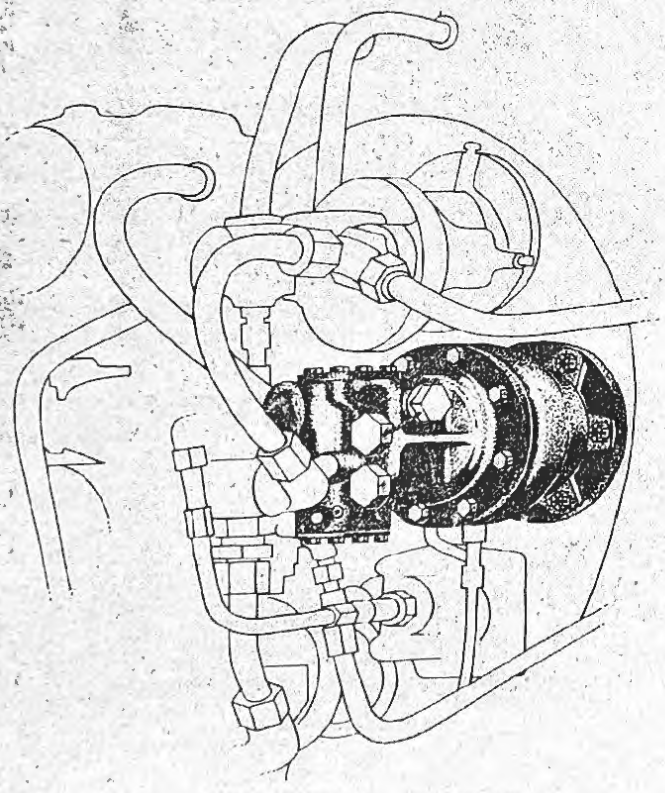
FIGURE 16

(6) GOVERNOR

The governor is a by-pass valve, controlled by centrifugal fly-weights, which act to prevent overspeed of the rotor in excess of 11,500 R.P.M. At this speed the governor fly-weights are rotating approximately 3400 R.P.M. The governor is mounted on the front of the accessories gear casing, in the "three o'clock position" and rotates in the counter-clockwise direction facing the mounting pad.

The operation of the governor is as follows: (Fig.18)

At speeds under 11,500 R.P.M., the only discharge from the governor is a slight leakage from the outlet port "C". At speeds over 11,500 R.P.M., fuel enters the governor through port "A", passes through the rotating plug type valve "B" and out the discharge port "C". That portion of the fuel under pressure, which is required to actuate the power-piston mechanism "L" is bled from the inlet supply "A", and passes through strainer "D", to the pilot valve "E". ASSUME that the gas-turbine rotor speed is 10,000 R.P.M. At this speed, the governor is running approximately 3000 R.P.M. and the weights "F" have pulled the originally semi-circular springs "G" into an elliptical shape. The springs are hinged in the weights "F". One spring is clamped at its midpoint to the spring driving bracket "H", while the other spring is about to touch the spring-loaded spindle "I". The spindle has not yet touched the adjustment screw "J", and so the pilot-biasing spring "K" is holding the pilot valve down, allowing inlet-pressure fuel to pass through the inlet port "A", and aid the spring in forcing the piston "L" to its uppermost position. Thus, the hole in the by-pass valve "B" is held at 90° to the main passageway, and only a slight leakage reaches the outlet "C". As speed increases, the weights "F" fly farther out, causing the free spring "G" to touch the spindle "I" and push it towards the speed adjustment screw "J". Just before 11,000 R.P.M., the spindle contacts the adjusting screw "J", which turns the linkage shaft "M", and tips the fulcrum lever on the eccentric, which in turn lifts the pilot valve "E" against the force of its biasing spring "K". As the pilot valve moves up, the lower port "N" is closed, and the port "O" is opened to the inlet pressure of the fuel. When the pressure builds up on the upper side of the piston, the pressure on the lower side is drained to the outlet "C". Thus, the piston is forced downward, rotating



ACCESSORIES GEAR CASING SHOWING THE GOVERNOR

FIG. 17

the by-pass valve, causing the eccentric to move down. It forces the pilot valve downward, closing the upper port and preventing further movement. If the partly opened position of the by-pass valve does not return enough fuel to the pump inlet to prevent further speed increase, the pilot valve is not restored sufficiently by the eccentric, and by-pass valve rotation continues until speed is limited to 11,500 R.P.M.

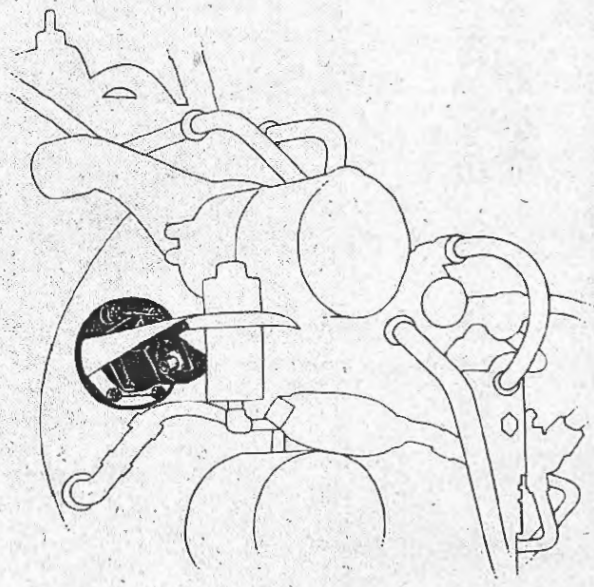
Two seals are used in this governor, one a cup-type seal "P" on the linkage shaft, prevents excessive leakage from the drained side of the valve housing into the weight and spring chamber "Q". The weight and spring casing is drained to atmosphere by a 1/8" tubing so that it runs dry at all times. The seal "R" on the splined shaft, prevents fuel from entering the accessories gear casing.

The adjusting screw located under the top plug on the side of the governor, is used to establish maximum speed for the turbine engine. One turn of the adjusting screw is equal to 300 R.P.M. change of speed of the rotor. Turning the screw clockwise reduces speed and counter-clockwise increases speed.

CAUTION: ADJUSTMENTS SHOULD BE MADE WHEN THE MAXIMUM R.P.M. IS BELOW 10,000. ADJUSTMENTS MADE OVER 10,000 MAY CAUSE OVER-SPEEDING OF THE ROTOR.

(7) TACHOMETER GENERATOR

The tachometer generator is located on the front of the accessories gear casing, in the "ten o'clock position", and is a two-pole three phase A.C. Generator, which is used with a suitable indicator to record turbine engine rotor speed. The counter-clockwise rotation of the tachometer generator, viewed from the mounting pad, is 1.000 to 2.404 of the rotor shaft speed. When the shaft of the generator is rotated, three-phase alternating current is transmitted to the synchronous motor of the indicator. The frequency of the voltage generated, is proportional to the speed of the turbine and the generator develops one cycle for each revolution of its rotor.

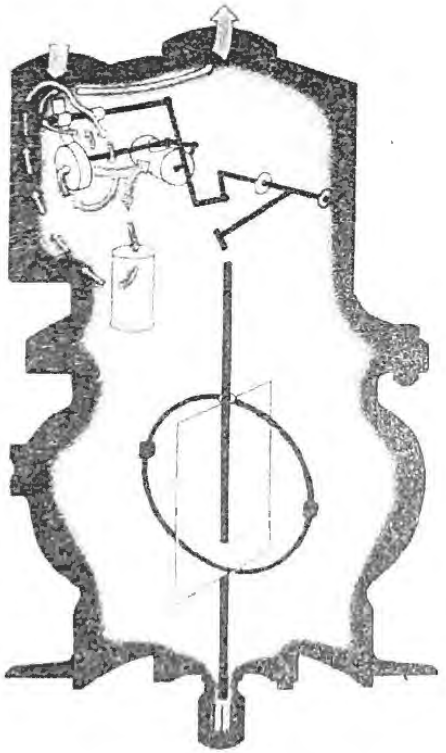


ACCESSORIES GEAR CASING SHOWING THE TACHOMETER

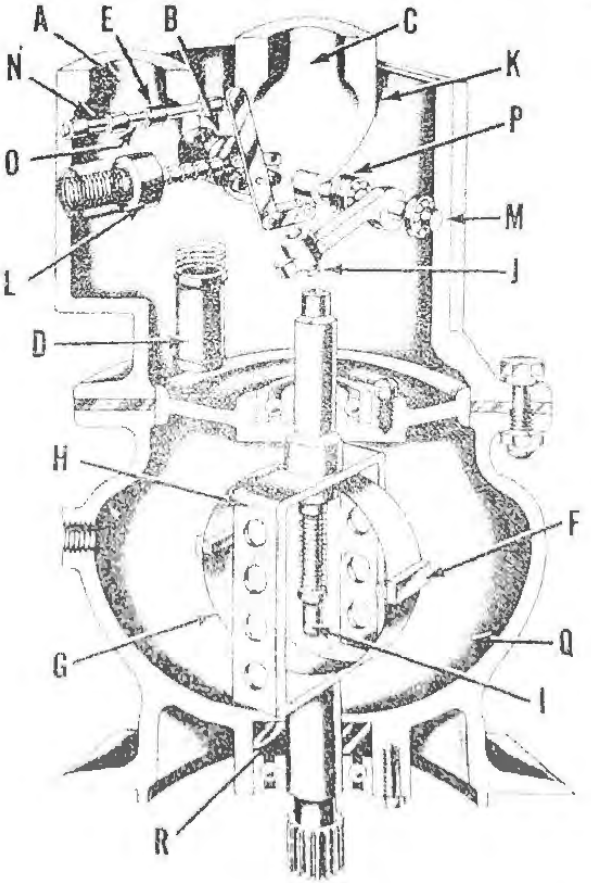
FIG. 19

GOVERNOR
J33 GENERAL ELECTRIC TURBINE ENGINE

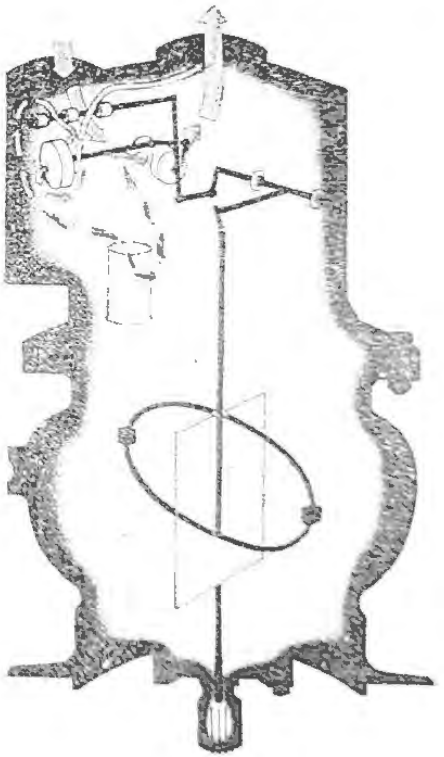
CONDITION AT NORMAL RATED SPEED



CUTAWAY VIEW OF GOVERNOR



CONDITION AT OVERSPEED



PRESSURE FUEL

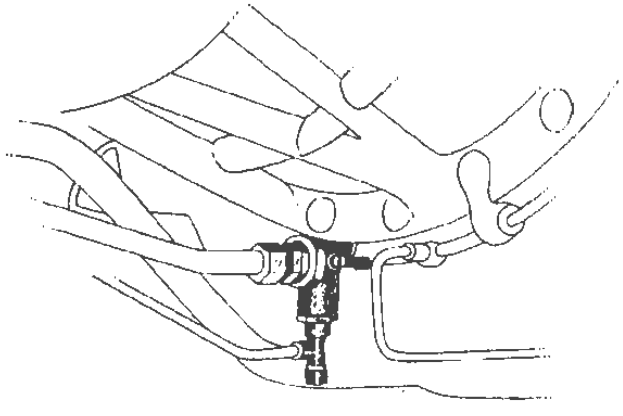
BY-PASS FUEL

(8) DRIP VALVE

The drip valve is located in the lower part of the fuel manifold in line with combustion chamber No. 8 and has three connections; one for the fuel supply, one for the cockpit pressure gauge, and the third for drainage to atmosphere. The purpose of this spring-loaded ball type valve, is to drain the fuel manifold of all fuel, when the fuel pressure within the manifold, falls below 5 P.S.I. gauge pressure. This action relieves pressure in the fuel nozzles, before combustion ceases, on stopping the turbine engine, giving a cleaner cutoff and prevents carbonization of the nozzles, and prevents fuel from dripping into the combustion chambers at low fuel pressures.

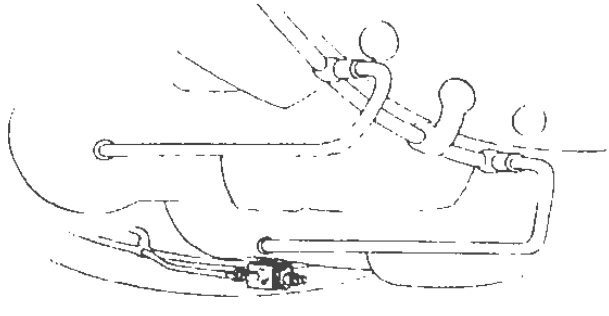
(9) COMBUSTION CHAMBER DRAIN VALVE

The combustion chamber drain valve is located under the turbine engine directly under No. 8 combustion chamber and is a spring-loaded ball type valve, used to drain any raw fuel that might have collected in the air adapters and combustion chambers during a false start. It is connected to a drain manifold, which in turn, is connected to the seven lower chambers, namely Nos. 5 to 11 inclusive. The upper chambers drain internally through the crossover pipes down to chambers 5 and 11. The valve is designed to open and allow fuel to drain to the atmosphere when the pressure in the chambers falls below 2 P.S.I. gauge pressure.



VIEW SHOWING THE DRIP VALVE

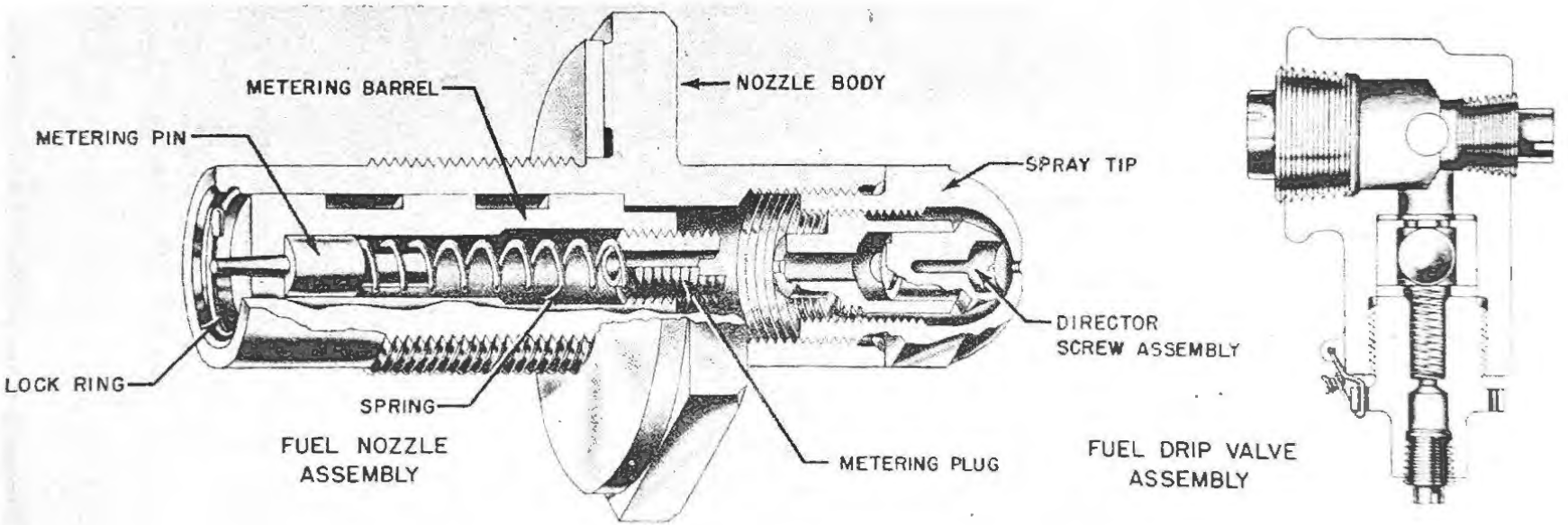
FIG. 20

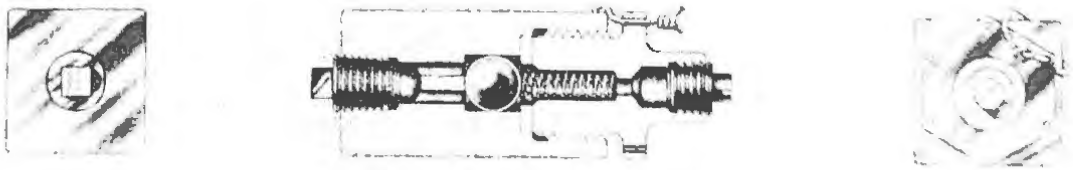


VIEW SHOWING THE COMBUSTION CHAMBER DRAIN VALVE

FIG. 21

FUEL NOZZLE - DRIP VALVE - DRAIN VALVE
J33 GENERAL ELECTRIC TURBINE ENGINE





Allison XD-4 SERVICE DEPT. 3-22-45

FIGURE 22

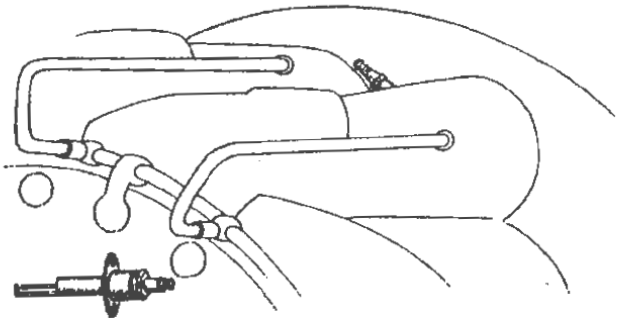
(10) SPARK PLUGS

The two spark plugs that are used in starting the turbine engine, are located in No. 7 and No. 14 combustion chamber air adapters. They are of the porcelain core type and have electrodes long enough to extend into the combustion chambers. The gap between the electrodes should be within the limits of .075" plus or minus .005". CHECK TABLE OF LIMITS.

(11) LUBE OIL FILTER

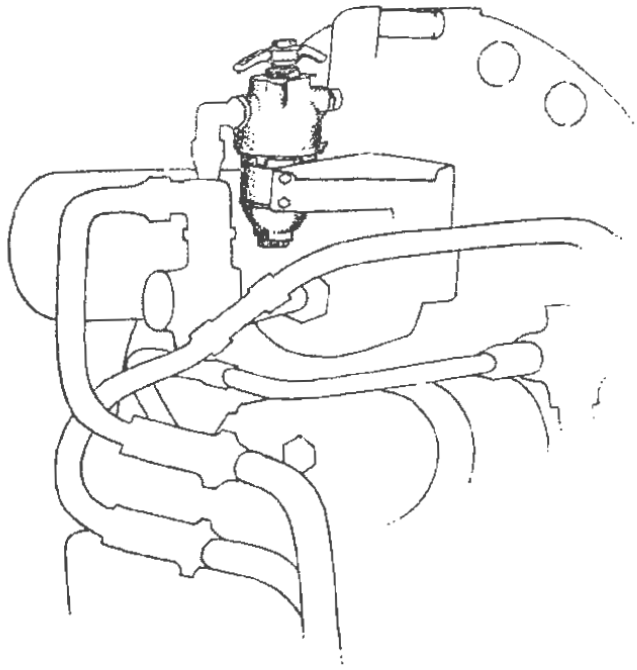
A lube oil filter of the purolator type, is mounted at the discharge port of the lube pressure pump. Its purpose is to remove foreign matter from the oil by its paper type filter element.

In the event of the element becoming clogged, there is, incorporated within the filter housing body, two by-pass valves set at 10 to 12 lbs. differential pressure, that will permit the oil to by-pass the filter element.



VIEW SHOWING THE LOCATION OF ONE OF THE TWO SPARK PLUGS FACING FRONT OF TURBINE ENGINE

FIG. 23

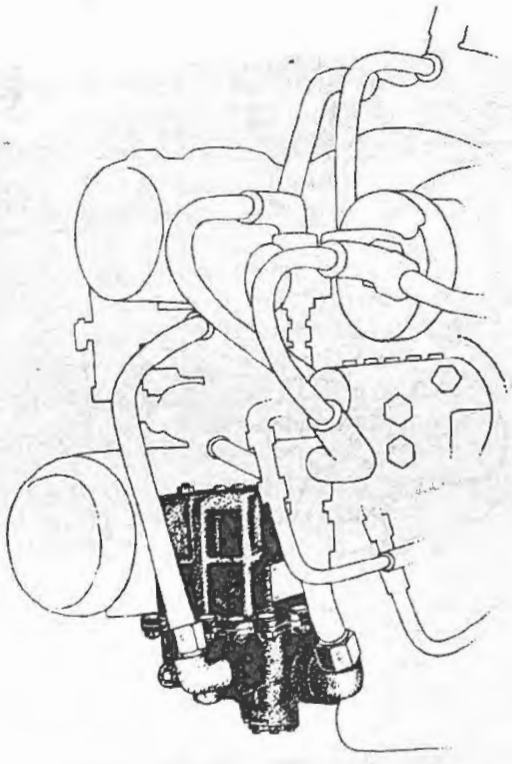


ACCESSORIES GEAR CASING SHOWING THE LUBE FILTER

FIG. 24

(12) BAROMETRIC

The barometric is an altitude compensated fuel pressure regulating valve, of the by-pass type. It provides the fuel system control valve with the proper fuel pressure to maintain constant rotor speed at changes of altitude for a given throttle setting. It is mounted at the front of the accessories gear case, directly in front of the lube oil pump, in the "six o'clock position". It is connected in parallel to the main fuel pump; that is, the inlet of the unit is connected to the outlet line of the main fuel pump, which in turn, is connected to the control valve. Then the outlet of the barometric is discharged into the inlet of the main fuel pump in the normal manner of any relief or pressure control valve. The main fuel pump is of the constant displacement type, the fuel discharged from it will not vary appreciably with any change in altitude from sea-level to 50,000 feet, at a constant rotor speed. But, the dense air at sea-level imposes a greater load on the compressor than the rarer air at altitude. Therefore, the sea-level or low altitude operation requires the use of more fuel to maintain the rated speed than is required at altitude. During increases in altitude, it is the function of the BAROMETRIC to by-pass the surplus fuel supplied by the pump, back to the inlet side of the main fuel pump, and during a decrease in altitude it compensates and regulates the fuel supply to the control valve, which in turn, supplies the additional fuel necessary to maintain constant rotor speed.



ACCESSORIES GEAR CASING SHOWING THE BAROMETRIC

FIG. 25

The action of the barometric (Fig. 26) is as follows: the by-pass connection to the high pressure line that connects the main fuel pump, and the control valve of the fuel system, enters the barometric at port "A" and passes into the center of the control valve "B"; then through ports in the valve that coincide with the fuel chamber at inlet port "A". The fuel then proceeds up through the valve body and out through the ports at the top of the valve to the outlet port "C". From the fuel chamber at the inlet port, a passage supplies fuel to the filter "N" and hence to the pilot valve "D", where it is available for the pilot valve to deliver to the top of piston "E" when it becomes necessary to change the amount of by-passing, which is dependent upon the position of the control valve "B" in its sleeve. The addition or reduction of the amount of fuel above the piston,

is controlled by the position of the pilot valve "D". A downward position of the pilot valve, allows fuel pressure to be admitted to the top of the piston "E", and an upward position of the pilot valve, opens a passage so that the tension of the spring under the piston "E" forces the fuel trapped above it into chamber "K" which is drained to the fuel outlet "C". When the pilot valve is in its center or neutral position the piston "E", and consequently the control valve "B", that controls the amount of by-passed fuel, are in a fixed position depending on the amount of fuel trapped above piston "E".

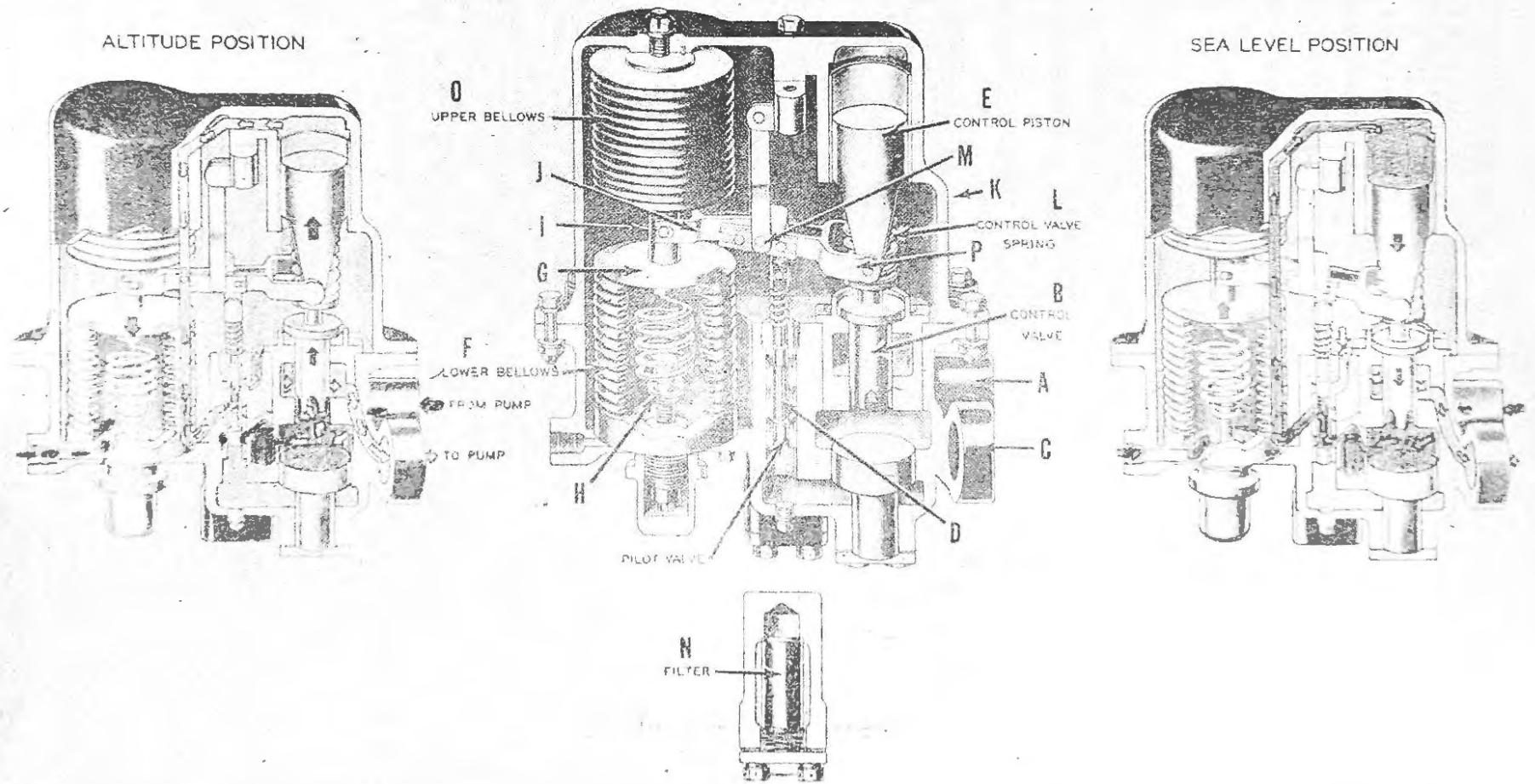
Two bellows, "F" and "O", are used in the unit so that fuel pressure variations within the casing "K" (which is connected to the by-passed fuel outlet pressure) are balanced against equal areas. Therefore, these fuel pressures that will be varying, will have no effect upon the action of the bellows "F" which actuates the pilot valve "D". This allows only atmospheric pressure changes to affect the bellows "F".

ASSUME that the airplane is at sea-level and starting a climb to altitude. Atmospheric pressure acting on the interior of bellows "F" is lessened. Therefore, the force exerted on the underside of the top plate "G" of the bellows "F", has reduced the force that was opposing the tension spring "H". The tension spring, therefore, pulls the bellows' connecting stem "I" downward. The downward movement of the stem "I", lifts the pilot valve "D" through the action of the lever "J" about its pivot point. This movement of the pilot valve "D" covers the pressure inlet to it, and opens the drain from above the piston, into the casing "K" and hence to the by-passed fuel outlet "C". The tension of the control valve spring "L" was upward on the positioned piston "E", and downward on the control valve "B" and was balanced by the high fuel pressure under the small area of the control valve. Draining of a portion of the trapped fuel above the piston "E", because of the new position of the pilot valve "D", allowed the spring "L" to move the piston "E" upward, which through the piston lever (P) pivoting about its point "M", restores the pilot valve "D" to its original position (neutral). At the same time, the high fuel pressure under the small area at the bottom of the control valve "B", moves it up to a new position, enlarging the restriction of by-pass. This movement was possible because the movement of piston "E" reduced the tension in spring "L", causing an unbalanced condition; and the high fuel pressure under the control valve moved it upward restoring the condition of balance. In so doing, a new position of the control valve, of less restriction was established. This meets the reduced fuel requirements of the gas turbine without manual re-adjustment of the control valve.

When the plane descends, increasing atmospheric pressure expands the bellows "F", and through its lever, forces the pilot valve downward. This allows high pressure fuel to be directed to the top of piston "E". The increased fuel pressure on the top, forces piston "E" downward, increasing the tension in the spring "L". This upsets the balanced condition that existed between the spring and the fuel pressure acting at the bottom of the control valve; and the control valve moves downward

BAROMETRIC
J33 GENERAL ELECTRIC TURBINE ENGINE

CUT-A-WAY VIEW OF BAROMETRIC



THROTTLE PRESSURE (T) BY PASS PRESSURE (O) ATMOSPHERIC PRESSURE (A)

Allison XC-1 SERVICE DEPT. 3-16-45

FIGURE 26

to re-establish the balanced condition. In doing so, it reduces the by-pass port opening. At the time that this rebalancing was taking place, the downward movement of the piston "E" through its lever pivoting about the point "M", brought the pilot valve back to the neutral position. The result of this entire operation was that less fuel was by-passed and the increased fuel requirements for the lower altitude operation were met.

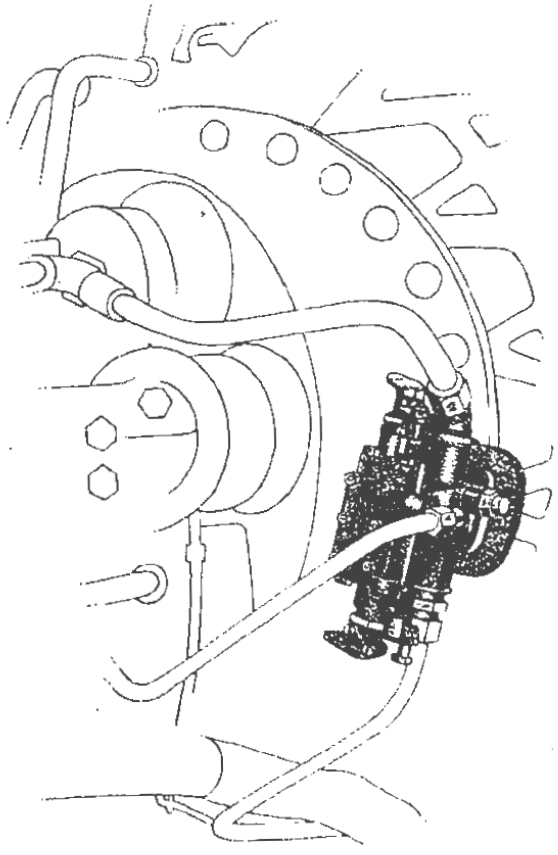
The barometric alters the main fuel pressure discharge approximately as follows:

ALTITUDE (ft.)	PRESSURE (psi)
Sea Level	380
10,000	275
20,000	190
30,000	130
40,000	100
50,000	80

(13) CONTROL VALVE

The control valve is a manually operated control of two elements in one casing. One element, the STOP COCK is a valve of two positions, open and closed. Its function is to admit or cut off the fuel supplied to the nozzles. The other element is the THROTTLE, and its purpose is to regulate the amount of fuel supplied to the nozzles, and consequently the rotor speed, from idling to maximum speeds at the discretion of the pilot. The control is located at the right side of the accessory casing, in the "three o'clock position".

Both elements of the control valve are connected by linkage to the pilot's cockpit quadrant. The stop cock is a poppet type valve, which, when open, permits fuel to flow to the burner nozzles. When it is closed, it provides a seal that prevents flow or leakage from the fuel pump and system to the nozzles. The operating torque on the lever control is a maximum of 100" lbs. to open the valve and 55" lbs. to close the valve. The THROTTLE is a sliding cylinder type valve. The maximum torque required on the operating lever is 30" lbs. to open and close it. The control shafts are actuated by the movement of the levers which have a spline fit on the shafts. The movement of the lever is an arc of 90°, and the movement from closed to open is counter-clockwise. When in the closed position, there is sufficient fuel passing to retain idling speed of the rotor at 3500



ACCESSORIES GEAR CASING SHOWING THE CONTROL VALVE
FIG. 27 2-27

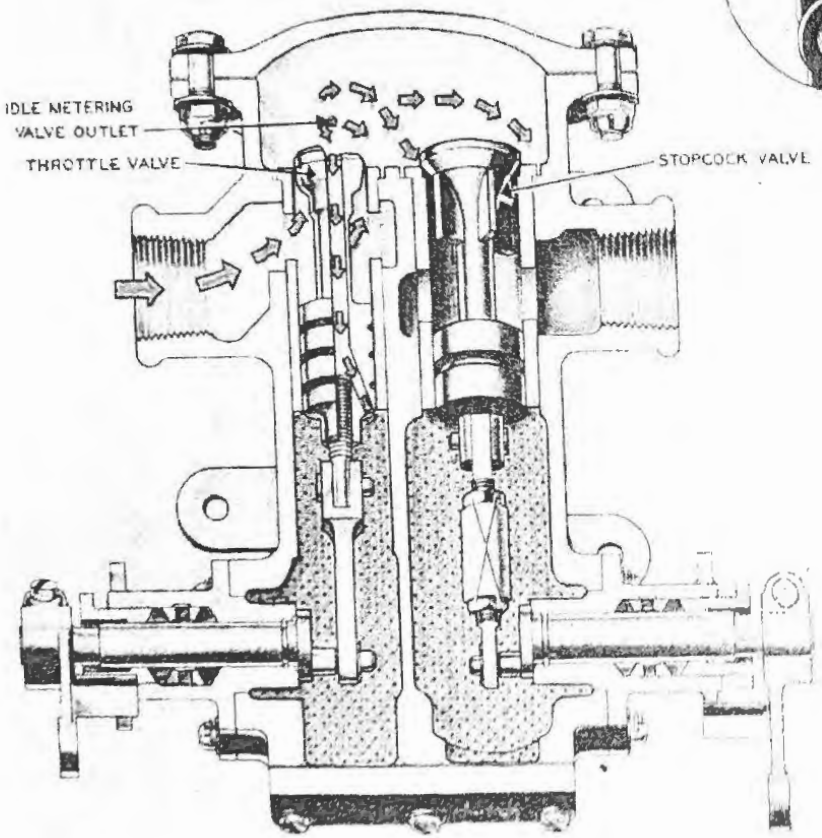
R.P.M. This fuel flow is adjustable at a needle valve that is under an acorn nut on the side of the unit. The arc of travel of the STOP COCK is also 90°, but clockwise (facing the lever), from the closed to the open position. The stop cock actually seats 10° before the dead closed position, but the further torque necessary to close the valve, springs the linkage enough, making a greater mechanical efficiency, both opening and closing, and maintains a better seal when closed.

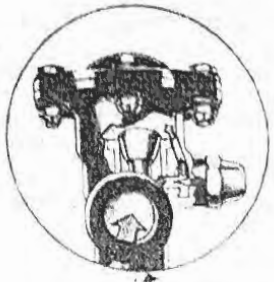
The fuel flow through the control valve is as follows: (Fig. 28).

The fuel enters at the inlet port "A" and passes through the opening between the tapered section of the valve and the flame tube at "B". Flowing through chamber "C" it passes stop cock valve "D", and continues to the outlet port "E". The pressure on the two sides of the THROTTLE are nearly balanced by interconnecting both ends of the valve through channels "F". Pressures on the STOP COCK are not balanced, because the stop cock is the final seal to prevent leakage into the fuel system. As a safety feature and a precaution against the possibility of fuel leakage through the control valve shafts "G", there are double seals at "H" with drains provided from them to the combustion chamber drain valve.

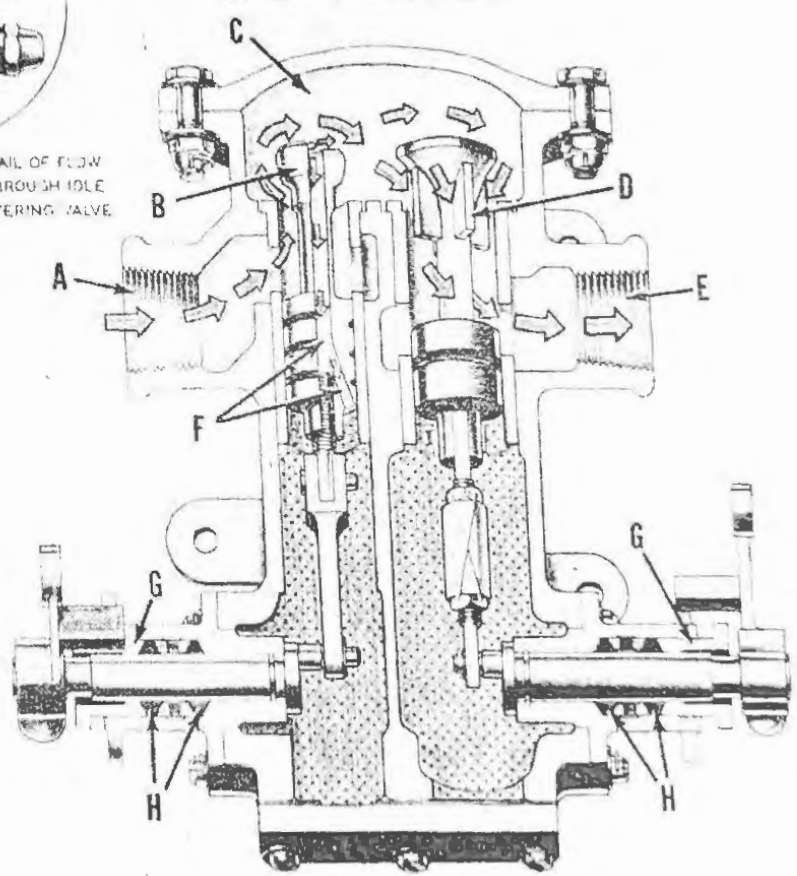
CONTROL VALVE
J33 GENERAL ELECTRIC TURBINE ENGINE

CUT-A-WAY VIEW
CLOSED POSITION





CUT-A-WAY VIEW
OPEN POSITION



FUEL FLOW

STATIC PRESSURE

Allison XD 3 SERVICE DEPT. 3-12-45

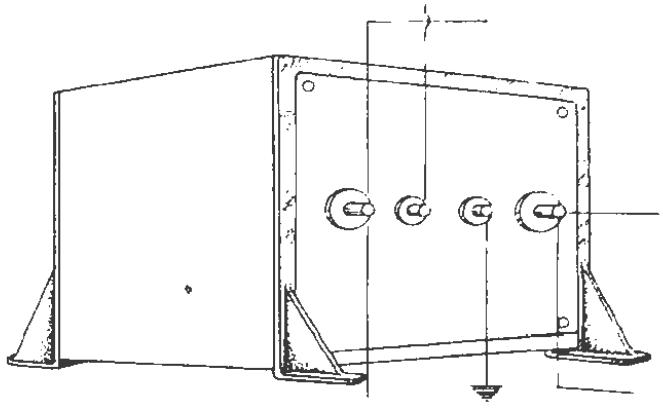
FIGURE 28

h. UNATTACHED ACCESSORIES

(1) STARTER CONTROL

The starter control is an electrical device which is used to limit the initial starting torque of the starter for approximately three-quarters of a second, while the pawls in the starter are being contacted. The starter control consists of two main contactors, a starter resistor, and a time delay relay. These are all assembled in one dustproof case that is mounted in an accessible location of the airplane.

When the main switch is closed on starting the unit, the time delay relay is energized; the points are separated by the current passing through its magnetizing coil. From this coil, the current passes through the resistor to the starter and the ignition coils. This current is very weak and of no great value, but is flowing at all times the main switch is closed. Holding the starter button in, energizes the first main contactor relay, which shunts the current that was separating the time delay points, and releases them. The heavy current now passes directly across the points and to the solenoid of the second relay, which short-circuits the resistor out of the circuit, and places full power of the battery on the starter. This sequence of operation takes about 3/4 of a second, during which time the starter was turning with low torque while taking up the lash in the pawls. No adjustment can be made to regulate the length of time that the time delay relay should hold the resistor in circuit. Refer to Fig. 31 for circuit.

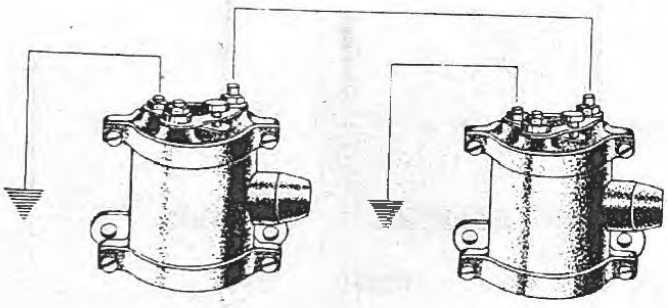


STARTER CONTROL

FIG. 29

(2) IGNITION COILS

There are two ignition coils, one for each spark plug, of the vibrator type, consisting of a primary and a secondary winding. They are mounted on the unit adjacent to the spark plugs, and are used in the starting operation to supply the plugs with high tension current for ignition in starting. Refer to Fig. 31 for circuit.



VIEW SHOWING IGNITION COILS

FIG. 30

i. MOUNTING TRUNNIONS AND BALL SUPPORT (Fig. 8, Section I)

To mount the engine in the ship or nacelle, it is equipped with two trunnions, one on each side, and a ball support at the front that is adjustable. The two trunnions at the "three and nine o'clock positions" are between the rear of the compressor casing and the ring and tube assembly. The ball support can be attached either straight up in the "twelve o'clock position", or down in the "six o'clock position", depending upon which of the two pads provided on the accessories casing are used.

j. ELECTRICAL SYSTEM

Referring to the schematic diagram (Fig. 31) of the electrical system; when the main battery switch "D" is closed, current is supplied to the switch "L" for the boost fuel pump "J". Current is also furnished to the "test" position of the spark test switch "F". When the switch "F" is in the test position, current is supplied to the coils "H" and the plugs "I" for testing only. After testing the operation of the ignition, the switch "F" must be returned to the "run" position. At the same time that the switch "D" is closed, current is supplied to the solenoid "B" thereby opening the points "K". This current of solenoid "B", to complete its circuit, reaches the ground-return by passing through the resistor "M" to the starting motor and the coils "H". This current flow is not heavy enough to operate either the starter or the coil, but does continue to flow as long as the switch "D" is closed. Pushing in on the starting button switch "E", energizes the coil "A", thereby closing the solenoid switch which completes the circuit to the starter through

STARTER ELECTRICAL CIRCUIT
J33 GENERAL ELECTRIC TURBINE ENGINE

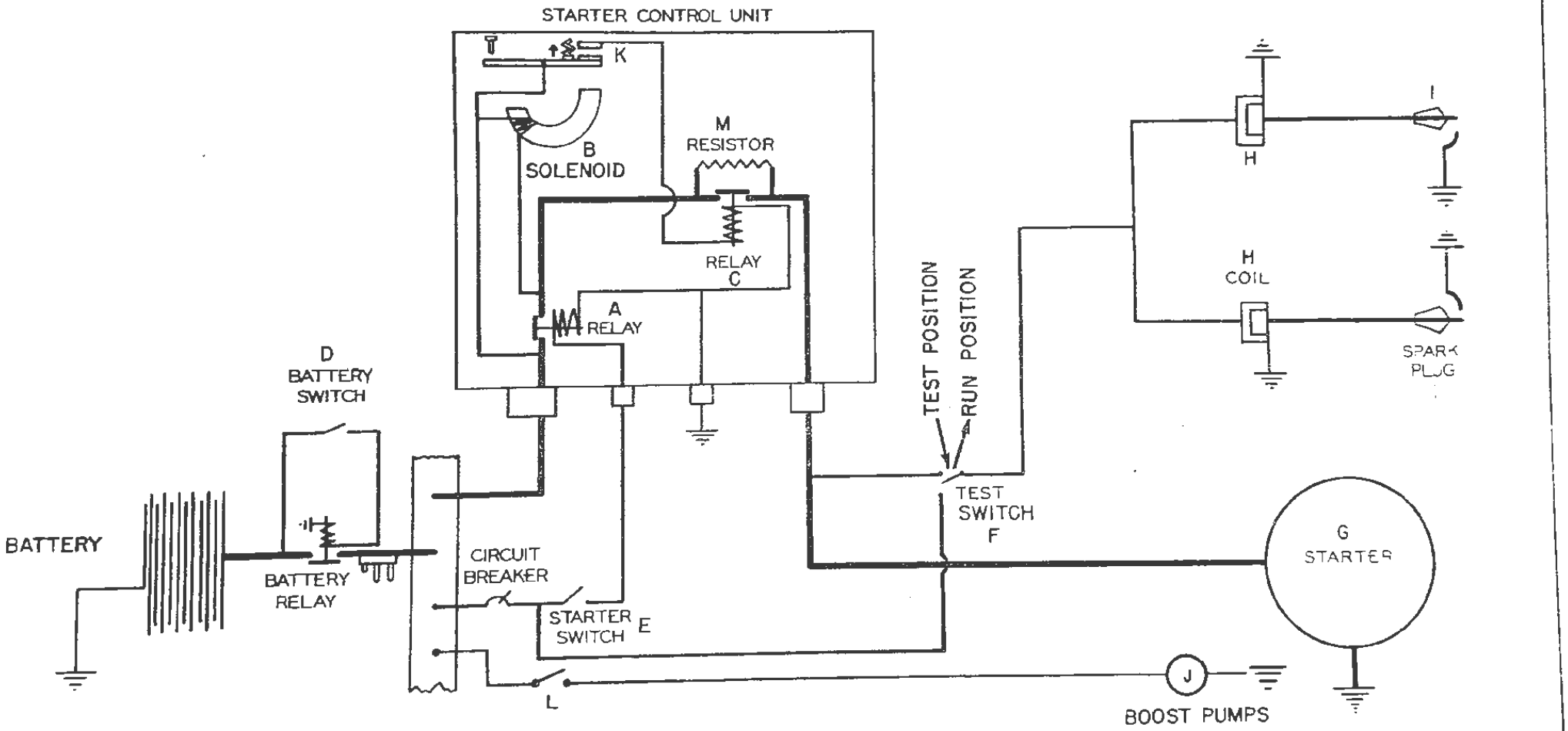


FIGURE 31

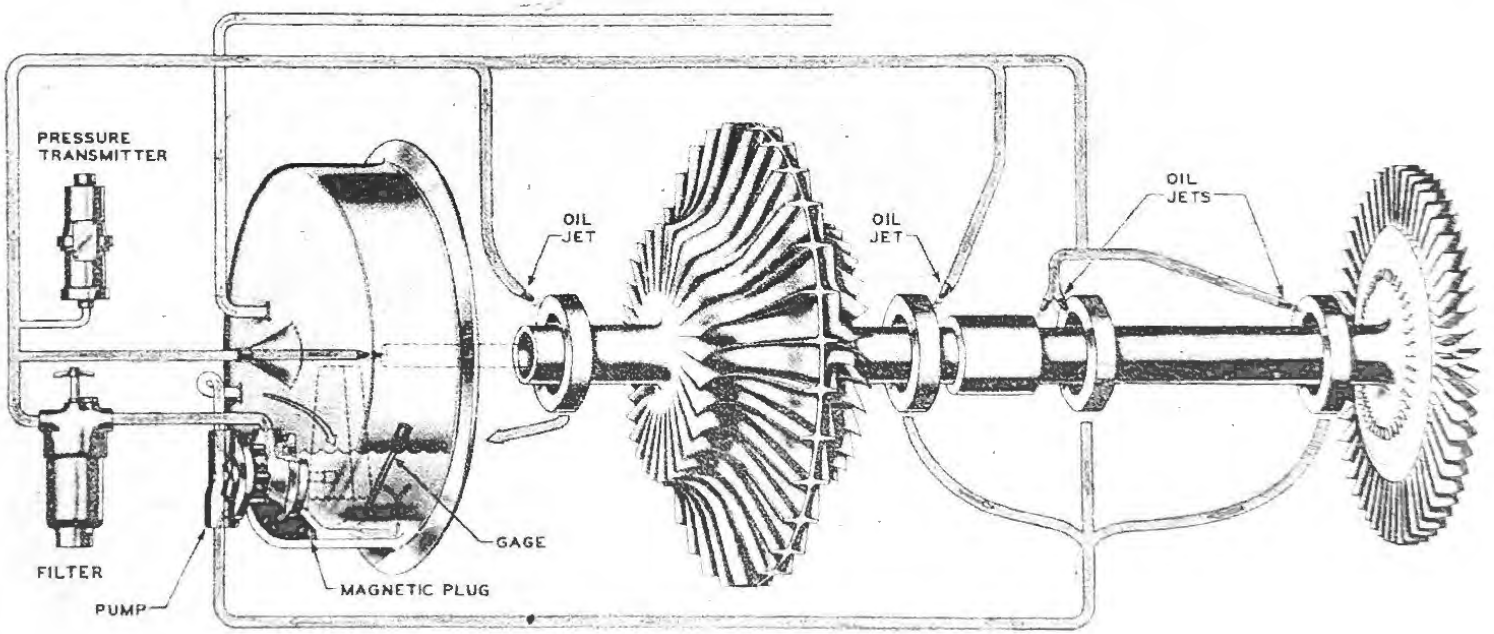
the resistor "M", which limits the starting current and turns the starter over gently to take up the lash in the clutch without shock. Approximately 3/4 of a second after the closing of the contacts "A", the magnetism in the solenoid "B" has dropped sufficiently to allow the spring to close the contacts "K". This closing of the contacts "K" energizes the solenoid "C". Therefore, the resistor "M" is bypassed, and now full current is applied to the starting motor which will rapidly accelerate the rotor to its starting speed in about 10 to 15 seconds. When full potential is supplied to the starter, it is also connected to the coils "H", and hence to the plugs by way of the spark test switch "F" being in the "run" position. Therefore, ignition is present immediately upon and during actuation of the starter "G". At approximately 1700 R.P.M. of the engine rotor, the centrifugally operated clutch disengages the starter automatically, and then it and the starter fuel pump are free from the rotor. On release of the push type starter switch "E", the coil "B" is reenergized, and the points "K" are separated, hence, full power is disconnected from the starter and the coils.

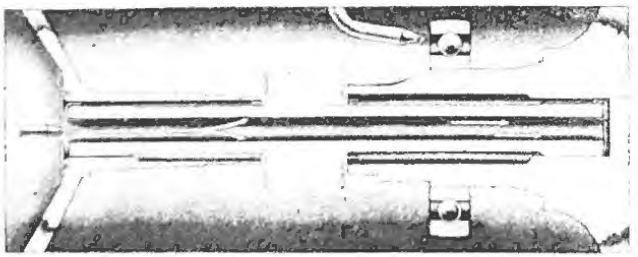
k. LUBRICATION SYSTEM

The J33 turbine engine is lubricated by a simple wet-sump system. The oil supply reservoir is an integral part of the accessories gear casing formed by the gear casing and the front bearing support casting, and has a maximum capacity of 14 quarts. The minimum supply is 6 quarts, and the desired level is 10 quarts, as checked by the bayonet type of gauge on the left side of the accessories casing. (Fig. 32).

Lubricating oil is delivered to the necessary parts of the turbine engine by means of a two element pump at the front of the gear casing, in the"six o'-clock position". One element of the pump is for pressure, and the other is to take care of the scavenging of the oil in the system. From the bottom of the oil reservoir in the gear casing, a passage leads to a port at the lube pump mounting pad, which matches with the inlet port of the pressure lube pump. In this passage, and directly below the lube pump in the front of the gear casing, is a magnetic plug. Lubricating oil passes from the pressure element of the pump to an oil filter, and then through external lines or tubing to the four bearings and the two couplings of the turbine engine. Oil seals are provided to prevent oil leakage past the front and the rear compressor bearings, and the rear turbine bearing. Unbalanced air pressures between the inside and the outside of the casings that contain the bearings, provide a further control of the oil leakage. Oil is returned to the reservoir by gravity and the scavenge element of the pump. The front bearing and the quill shaft of the accessories drive, drain directly into the reservoir. The

LUBRICATION SYSTEM – SCHEMATIC
J33 GENERAL ELECTRIC TURBINE ENGINE





ACCESSORY DRIVE COUPLING SHAFT

LUBE PUMP DRIVE GEAR TRAIN

ROTOR COUPLING

PRESSURE OIL SCAVENGE OIL VENT

Allison XF-1 SERVICE DEPT 4-8-45

FIGURE 32

oil from the other three bearings, and from the rotor coupling, drain into a common drain sump from which it is picked up by the scavenge element of the pump, and returned to the accessories gear casing reservoir by an external tube, that connects with an elbow at the front of the gear casing in the "eight o'clock position", just to the left of the generator mounting pad.

All the gears and the anti-friction bearings in the accessories gear casing are lubricated, by means of the splash system, emanating from the lube pump drive gear. This gear is located in a special compartment under the oil supply level. Oil is admitted to this compartment through an orifice, which controls the amount of oil that is used for the lubrication of gears and bearings, and prevents the oil in the reservoir from being churned into foam. The design and location of the lube pump and its intake, are such that it is supplied with oil at a safe minimum level at any reasonable attitude of dive or climb. It is possible to maintain inverted flight for short periods without appreciable loss of pressure. In the direct inverted attitude the lube pump runs dry, but the splined gear couplings and the bearings will operate without lubrication for short periods and not be damaged.

1. FUEL SYSTEM

(1) COMPONENTS

Referring to Fig. 33, the fuel system consists of the following elements:

The airplane fuel tanks or supply.

The booster pumps.

Transfer valves.

The fuel filter.

The main fuel pump and check valve.

The starting fuel pump, check, and relief valve.

The barometric.

The governor.

The control valve (throttle and stop cock.)

The drip valve.

The fuel pressure transmitter.

The fuel manifold and nozzles.

(2) ACTION OF SYSTEM

When the rotor is actuated by the starting motor in the act of starting the engine, the main fuel pump is turning over slowly due to its speed reduction to the rotor and consequently, is not producing sufficient pressure to start the engine. During this operation, the starting fuel pump, that is driven separately by the starter gear, assists the main fuel pump in building up fuel pressure and delivering it in sufficient quantities to the nozzles for starting the engine. After the rotor builds up to approximately 1700 R.P.M. because of the starter operation, the centrifugally operated clutch disengages the starter, and the main fuel pump takes over and delivers fuel to the nozzles for further increases of speed. At

this time, the check valve in the starting fuel outlet line, prevents fuel being forced back through the starting fuel pump, and as the starting fuel pump will still be functioning, the pressure relief valve set at 200 p.s.i. returns the output of the starting fuel pump to the inlet side again. Both the governor and the barometric act as a by-pass, or pressure relief, of the main pump under certain operating conditions, as this pump has constant displacement characteristics. The governor by-passes fuel in sufficient quantities to prevent over-speeding of the rotor; or exceeding 11,500 R.P.M., which is the maximum allowable. The barometric by-passes fuel in order to maintain, for a given cock-pit setting of the throttle, a constant rotor speed regardless of altitude. By means of the throttle, the pilot can vary the speed of the rotor of his engine at will, by changing the amount of fuel flow to the nozzles. The stop cock side of the control valve, connected to the pilot's quadrant, is used to completely shut off the fuel flow to the nozzles, thereby stopping the turbine engine. A drain manifold and drain valve, which are connected to the lower 7 combustion chambers, drain off any fuel accumulation in the air adapters when the engine is shut down. The drip valve, in the lower section of the fuel manifold, also assists in preventing a fuel accumulation on shutdown, and connected to it is the fuel pressure transmitter. A detailed description of the component parts of the fuel system is given in the preceding paragraphs of this section.

The fuel nozzle, is not considered an accessory, but is an important component of the fuel system and is described herewith (Fig. 22).

(3) ACTION OF FUEL NOZZLES

A fuel nozzle, located in each of the fourteen air adapters. (Fig. 34) is the means of introducing atomized fuel into the combustion chambers from the fuel manifold. They are positioned accurately in each air adapter by bottoming the body against the fuel passage. Located immediately ahead of the fuel nozzle, is a filtering element through which all fuel must pass before entering the nozzle.

The fuel nozzle is composed of the body and the two assemblies: the metering valve assembly, and the spray tip assembly.

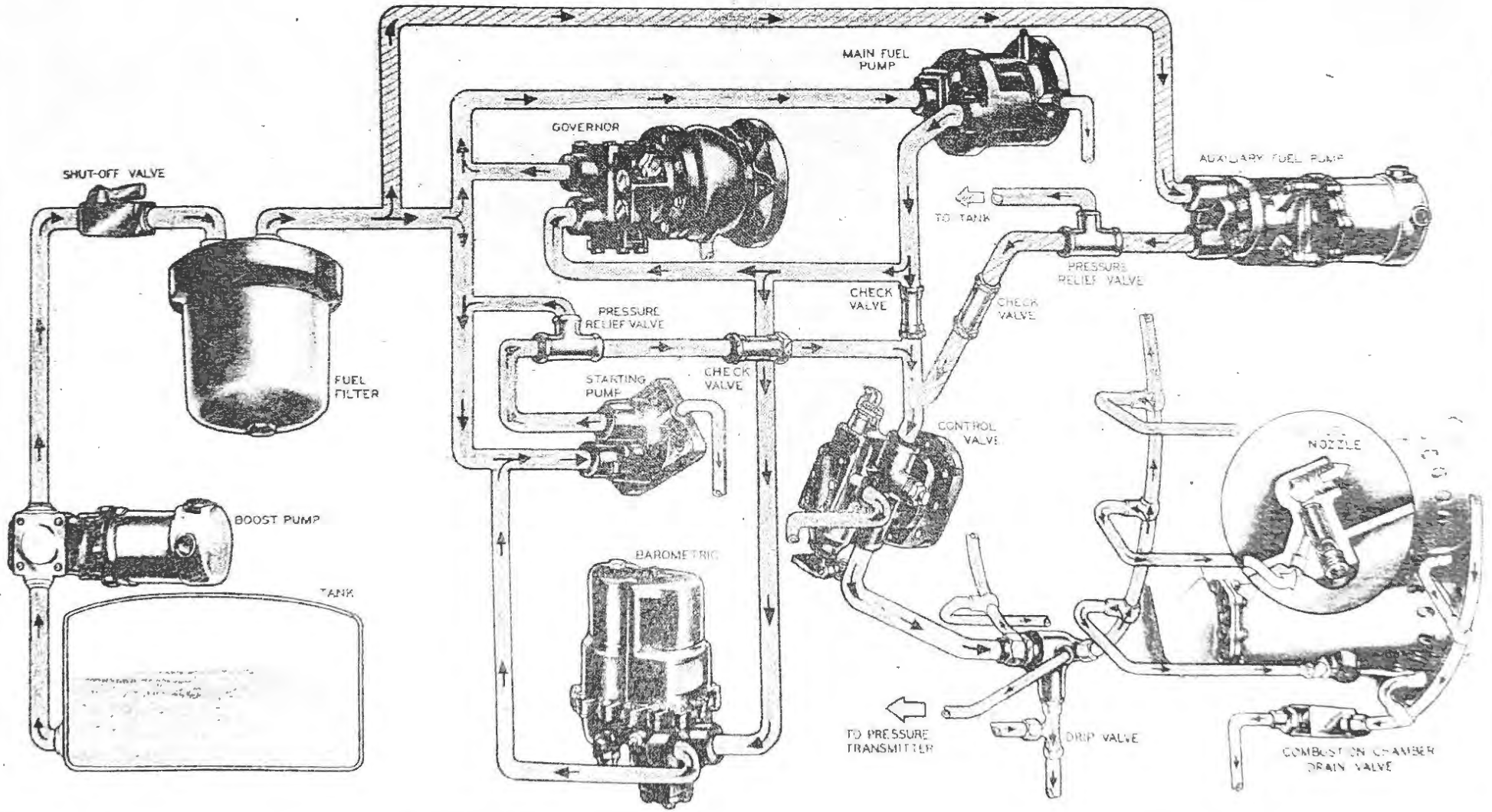
The metering valve assembly consists of: the metering barrel, metering pin, lock ring, spring, and metering plug.

The spray tip assembly consists of: the spray tip, and the director screw assembly.

The nozzles are tested for spray pattern, and then tested in sets of fourteen for equal fuel flow. Nozzles are serviced as COMPLETE SETS, of fourteen each, and none should be separated from the set.

Fuel pressure exerted against the spring-loaded metering pin, moves the pin according to the pressure exerted, and thus meters the fuel as it enters the nozzle. At 100 p.s.i. the metering pin is in a full open position. From the metering body, the fuel flows through tangential slots in the spray tip, and out through the orifice into the combustion chamber. The arc of spray from the orifice, at fuel pressures below 125 p.s.i., is approximately 70 to 80 degrees, but at higher pressures the arc narrows and the flow is extended farther into the combustion chamber.

FUEL SYSTEM - SCHEMATIC
J33 GENERAL ELECTRIC TURBINE ENGINE



FUEL AUXILIARY FUEL BY-PASS FUEL DRAINS

Allison XD-1 SERVICE DEPT 3-19-45

FIGURE 33

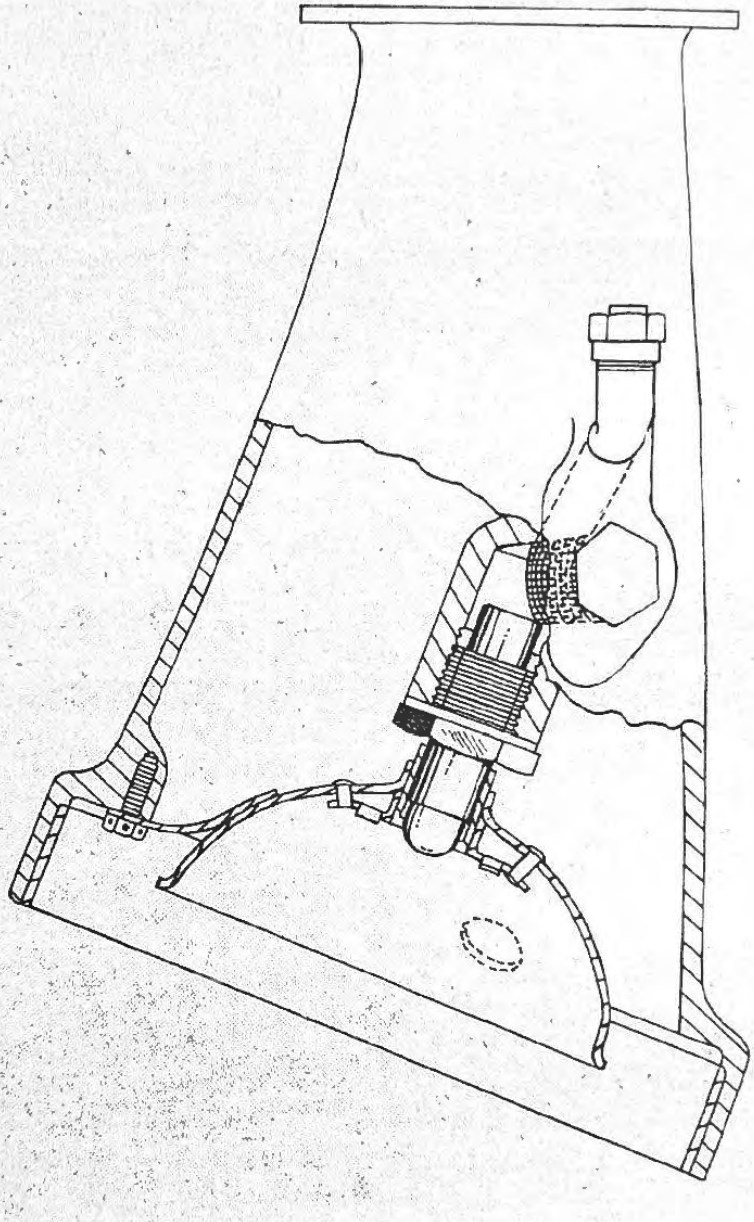


FIG. 34

R E S T R I C T E D

I N D E X T O S E C T I O N 3

J33 T U R B I N E E N G I N E

D I S M A N T L I N G A N D D I S A S S E M B L Y

I N T O

UNIT ASSEMBLIES AND SUB-ASSEMBLIES

R E S T R I C T E D

S E C T I O N 3

J33 T U R B I N E E N G I N E

D I S M A N T L I N G A N D D I S A S S E M B L Y

I N T O

(UNIT ASSEMBLIES AND SUB-ASSEMBLIES)

1. GENERAL INSTRUCTIONS

An important feature of the J33 turbine engine which contributes greatly to ease of overhaul and maintenance, is its breakdown into four major assemblies.

Proper equipment should be available and made ready before actual disassembly. Such equipment includes a chain hoist of at least one ton capacity, lifting slings for various parts, proper hand tools, and special tools, receptacles for parts, and an engine assembly stand.

While handling parts of any aircraft engine, extreme care must be used to prevent damage. Even slight nicks, scratches or dents may easily be the cause of serious failure under service conditions. Any part so damaged must undergo rigid inspection before use, or be replaced.

To guard against such damage, as well as to save time and prevent loss, suitable containers must be available in which to place small parts, nuts, bolts, etc., during the disassembly operation.

Other important rules to observe during disassembly include:

a. Dispose of all safety devices as they are removed.

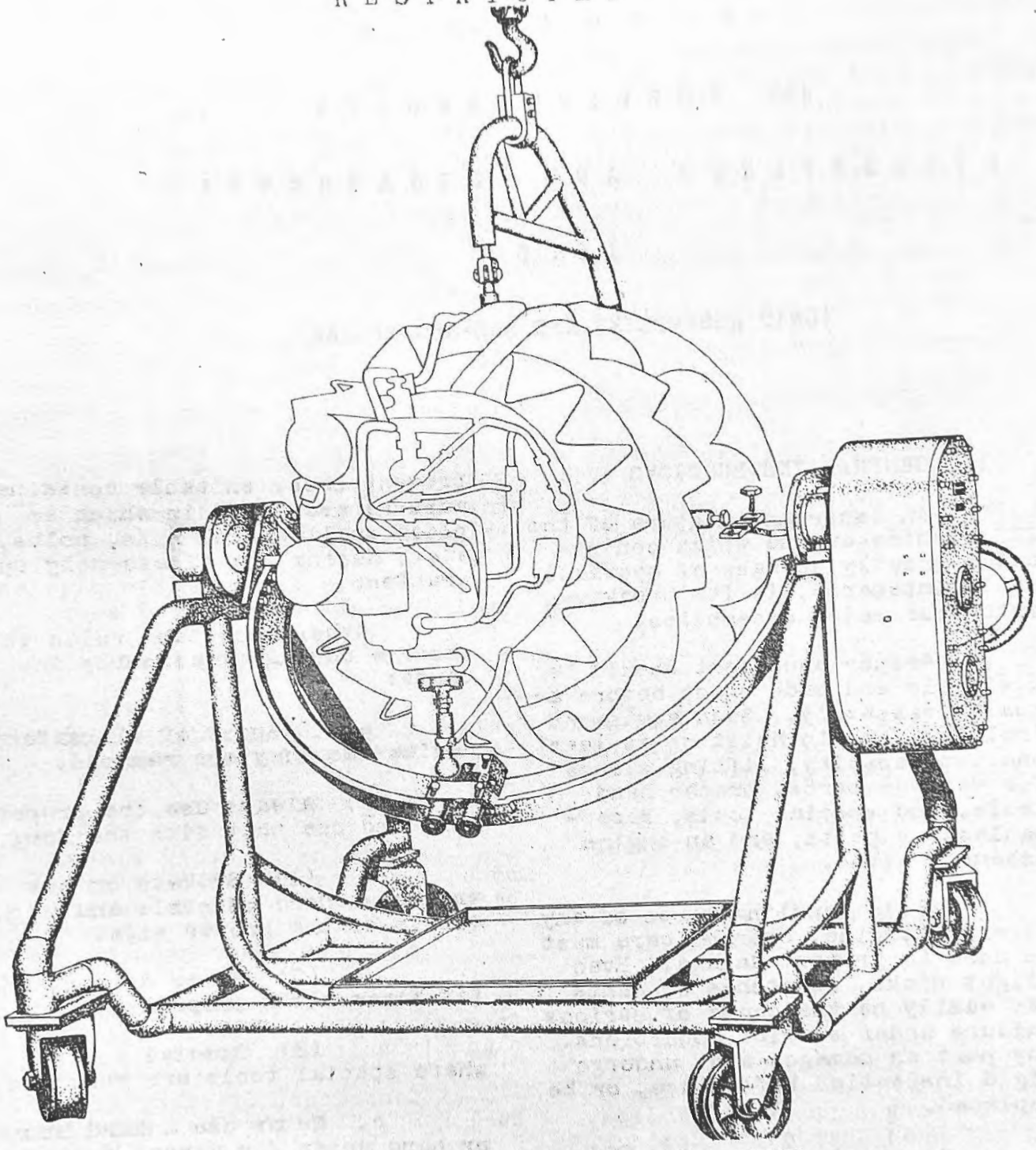
b. Always use the proper tool and one that fits the job.

(1) Sockets or box wrenches where possible and always of the proper size.

(2) Screw drivers that fit screw slots properly.

(3) Special tools where special tools are required.

c. Never use a hard hammer or hard drift for direct driving on metal - always use a hammer or drift of soft material to prevent



J33 TURBINE ENGINE IN DISMANTLING STAND

FIG. 1

damage to parts.

Each major assembly is removed as a unit and remains as such until disassembled individually for inspection and repair.

As previously stated, the engine is composed of four major assemblies. They are named below in the order of their disassembly

EXHAUST UNIT ASSEMBLY

TURBINE UNIT ASSEMBLY

ACCESSORIES GEAR ASSEMBLY

COMPRESSOR UNIT ASSEMBLY

The EXHAUST UNIT ASSEMBLY is made up of the following subassemblies: The Outer Cone Assembly, Inner Cone Assembly and Brace Assembly.

The TURBINE UNIT ASSEMBLY consists of the following subassemblies: The Air Adapter Assemblies, Turbine Wheel Assembly, Rear Bearing Support Assembly and the Ring and Tube Assembly.

The ACCESSORIES GEAR ASSEMBLY includes the following subassemblies: The Gear Casing Assembly, Rotor Cage Assembly, and the Gear and Shaft Assemblies, which furnish the drives for the accessories.

The COMPRESSOR UNIT ASSEMBLY includes the following subassemblies: The Front and Rear Truss Rings, Front and Rear Impeller Bearing Support Assemblies, Front and Rear Compressor Casings, Diffuser Assembly, Compressor Rotor Assembly, and the Fuel Manifold Assembly.

The following procedure begins with the engine, either installed on an engine dolly, or in a shipping box.

2. DISMANTLING OF ENGINE

a. SECURE ENGINE IN STAND - DRAIN OIL.

Attach engine sling No. Z31,202 to lift rings No. 7 at the ring and tube mounting flange and compressor casing mounting flange.

Place engine in stand No. Z51,168, and fasten securely at the trunnions and ball support. (Fig. 1)

Remove the magnetic plug and drain the oil from engine sump.

b. DISCONNECT LINES

Disconnect and remove all outside lines, including check and relief valves of fuel system.

c. MARK FLANGES

Mark the mounting flange of each accessory and housing before removal to aid in replacing.

d. REMOVE ACCESSORIES

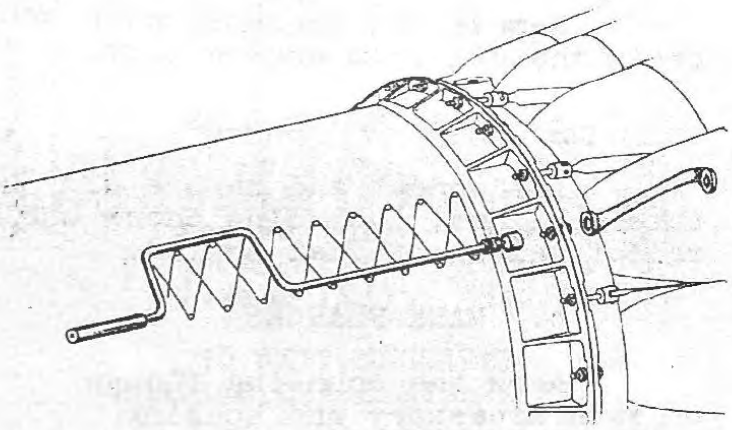
Remove following accessories from Accessories Gear Casing and place in suitable location.

Generator, Starter, Main Fuel Pump, Starting Fuel Pump, Oil Filter, Lube and Scavenge Oil Pump, Governor, Tachometer Generator,

Barometric, and Control Valve.

e. REMOVE EXHAUST UNIT ASSEMBLY

(1) With a wrench holding the clevises to keep from twisting the tie straps, remove the fourteen (14) 3/8"-16 nuts from the clevises, and the fourteen (14) 3/8"-16 x 1" long bolts from ring mounting flange. As the last bolts are removed, two men should hold the cone assembly, and place it on a table or other suitable location for inspection. (Fig. 2)



REMOVAL OF EXHAUST UNIT ASSEMBLY

FIG. 2

f. INVERT STAND

Invert stand so the turbine wheel is at the top.

g. LOOSEN FUEL MANIFOLD

Unscrew the union nuts which attach the fuel manifold to air adapters.

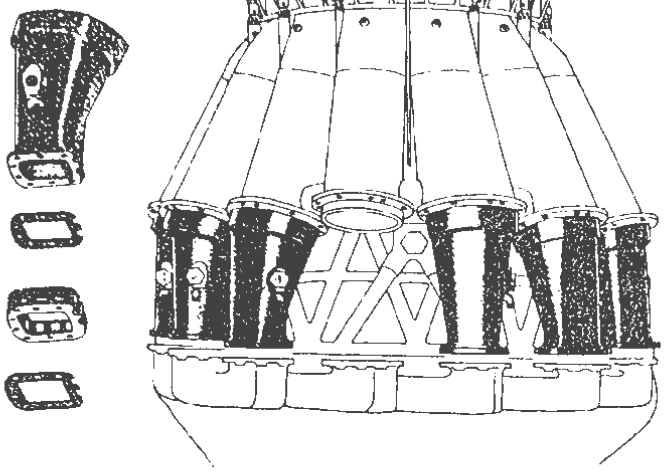
h. REMOVE TURBINE UNIT ASSEMBLY

(1) Remove spacers and air adapters, Fig. 3.

(a) Remove the ten (10) 1/4"-28 x 1-3/4" long cap screws from each of the flanges of the fourteen (14) spacers.

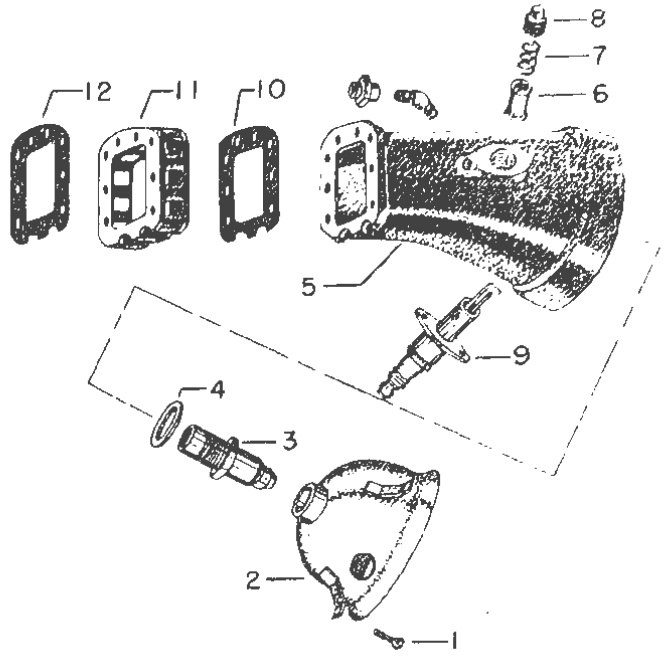
(b) Tap spacers with pyralin hammer and pull them out.

(c) Pull down on adapters; (do not let them hit the compressor casing), until they clear the piston rings, and remove them to a suitable location.



REMOVAL OF SPACERS AND AIR ADAPTERS

FIG. 3



(1) Cap Screw
(2) Dome
(3) Nozzle
(4) Gasket
(5) Adapter
(6) Filter
(7) Spring
(8) Plug
(9) Spark Plug Assy.
(10) Gasket
(11) Spacer
(12) Gasket

EXPLODED VIEW OF AIR ADAPTERS AND SPACERS

FIG. 4

(2) Disassembly of adapters, Fig. 4.

(a) Remove spark plug assemblies from air adapters Nos. 7 and 14. The plug and its adapter remain as an assembly.

(b) Remove the three (3) #10-24 x 5/8" long cap screws from each of the domes, and lift them from the adapters.

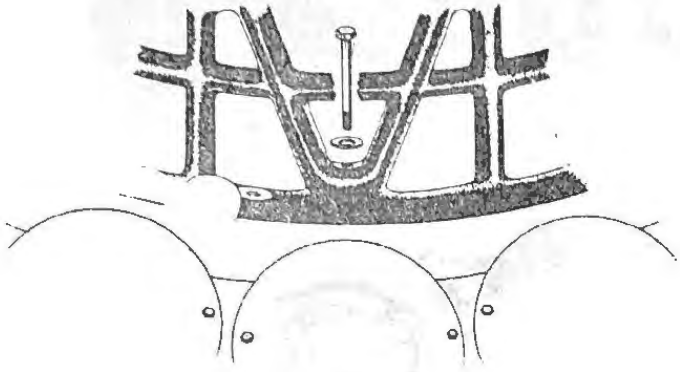
(c) Remove nozzles and place them in container.

(3) Attach sling No. Z51,257 to the ring flange.

(4) Remove Turbine Unit Assembly.

(a) Remove the twenty-six (26) 3/8"-24 nuts from

the rear mounting flange of the rear truss ring.



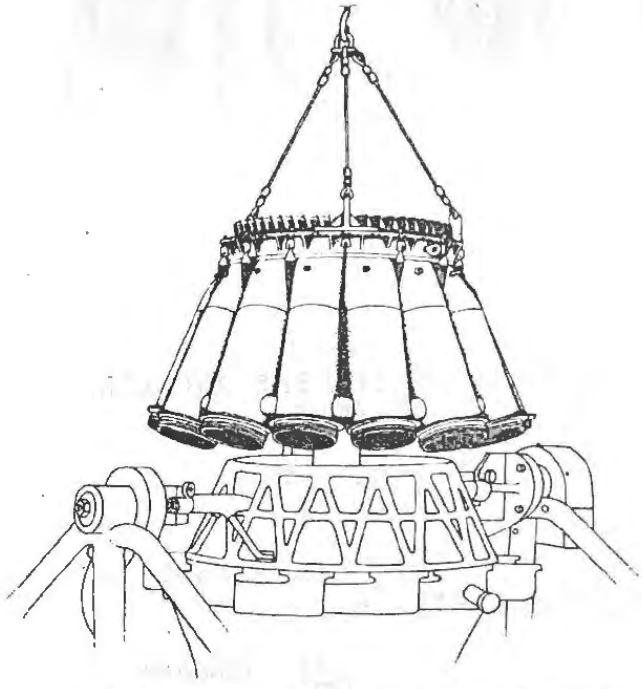
REMOVAL OF BOLTS FROM REAR MOUNTING FLANGE OF REAR TRUSS RING

FIG. 5

(b) Remove the small brackets, which help tie the ring and tube assembly to the rear bearing support assembly. Each pair is secured with two (2) #10-32 x 19/32" long cap screws on the outer end, and by mounting flange bolts on inner end.

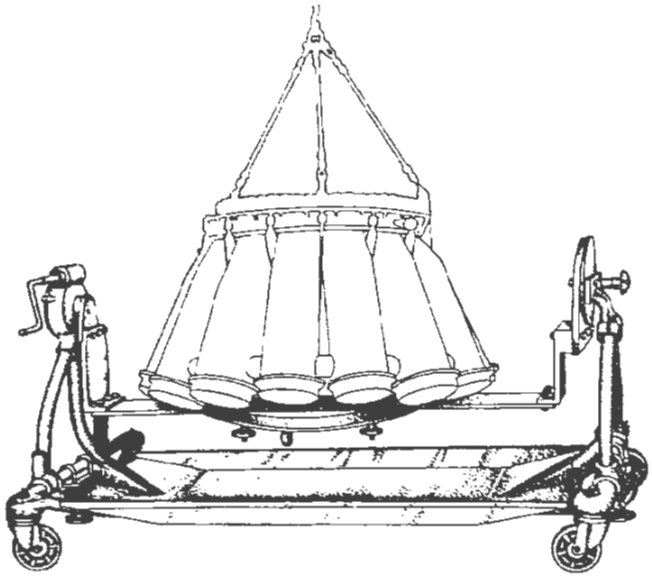
(c) Remove oil line bracket from compressor mounting flange. The rest of the lines are taken off later.

(d) Lift Turbine Unit Assembly from Compressor Assembly, Fig. 6, and position the front end of the bearing support, so that it can be placed on the stand No. Z51,196. Secure with six bolts, Fig. 7. Remove the composition gasket from the flange of compressor casing.



REMOVING TURBINE UNIT ASSEMBLY

FIG. 6



TURBINE UNIT ASSEMBLY IN STAND

FIG. 7

(e) Remove the combustion chamber drain valve.

(f) Remove the drip valve. Disconnect from the fuel manifold by unscrewing the two union nuts.

i. REMOVE THE TWO IGNITION COILS.

Coil and bracket are removed together.

j. ROTATE STAND.

Place stand with engine in horizontal position.

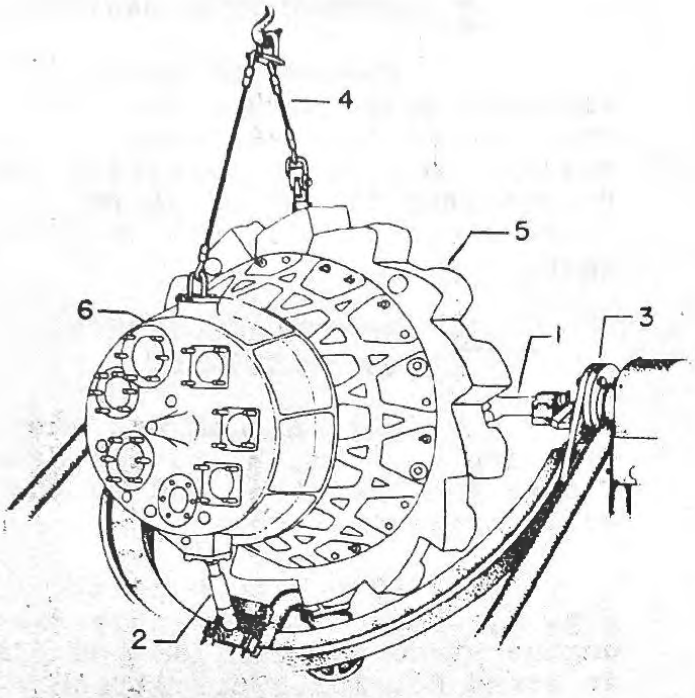
k. REMOVE FUEL MANIFOLD.

Remove the seven (7) brackets which secure the fuel manifold to the compressor casing. Remove it carefully and do not bend it out of shape. Place where it will not be damaged.

l. REMOVE ACCESSORIES GEAR ASSEMBLY.

(1) Attach one end of sling No. Z51,121 to diffuser flange and the other end to the accessories gear case.

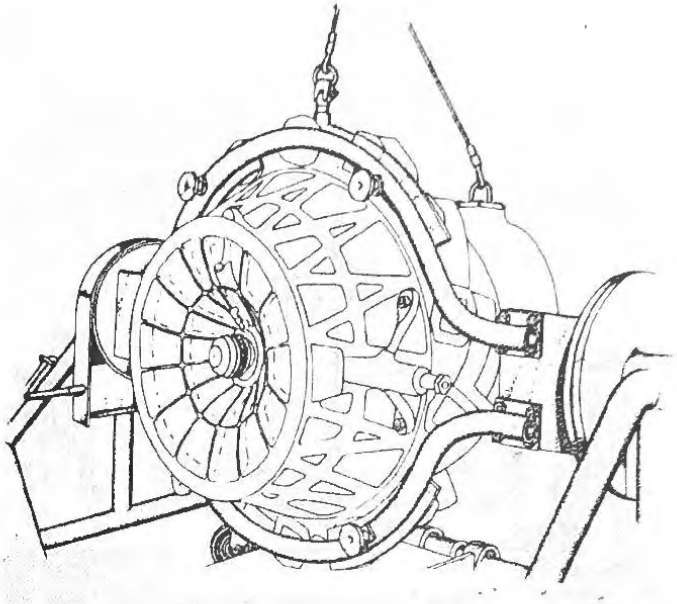
(2) With a hoist, Fig. 8, remove the assembly from engine stand No. Z51,168 and place in stand No. Z51,176. Attach securely to the diffuser flange, Fig. 9.



1. Trunnion
2. Front Ball Support
3. Engine Stand
4. Lift Sling
5. Compressor Assembly
6. Accessories Gear Assembly

REMOVING COMPRESSOR UNIT AND ACCESSORIES GEAR ASSEMBLIES FROM ENGINE STAND

FIG. 8

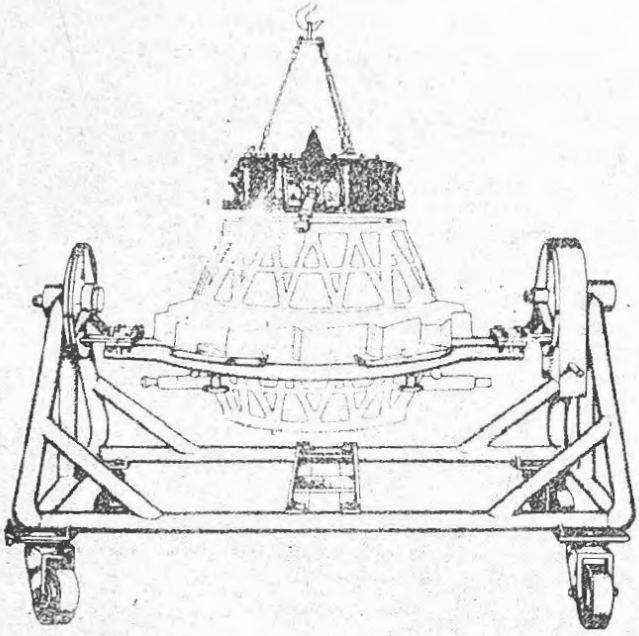


PLACING COMPRESSOR UNIT AND ACCESSORIES GEAR ASSEMBLIES IN COMPRESSOR UNIT STAND

FIG. 9

(3) Turn stand until the Accessories Gear Assembly is at the top, and attach sling No. Z51,205 to the front side of gear case, so it can be lifted evenly.

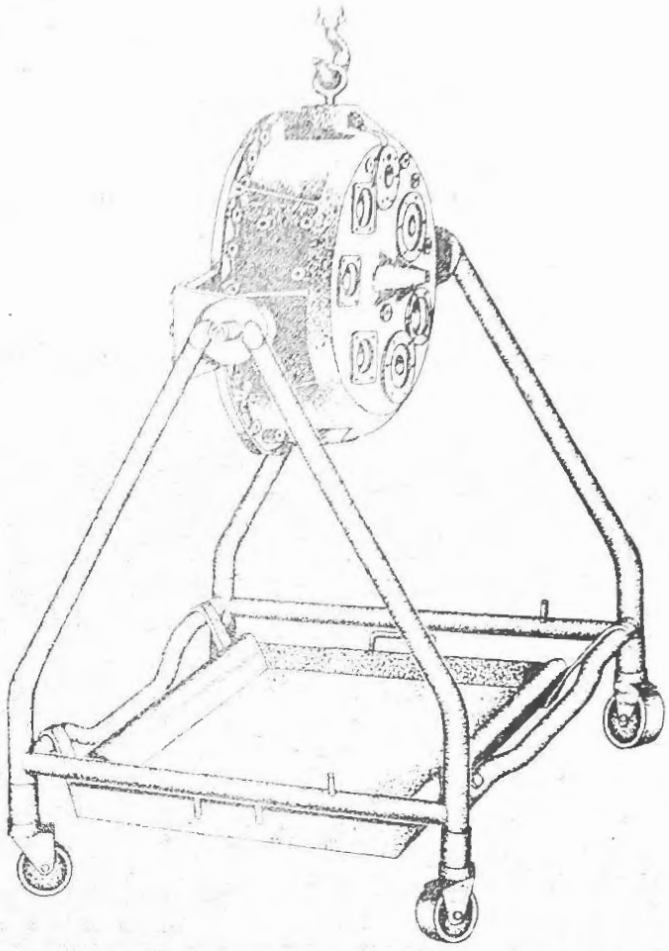
(4) Remove the cotter pins and the twenty-six (26) bolts from the mounting flange. Separate the Accessories Gear Assembly from the Compressor Unit Assembly. There are thirteen (13) 5/16"-24 x 2-3/4" long and thirteen (13) 5/16"-24 x 3-11/16" long bolts.



ACCESSORIES GEAR ASSEMBLY SEPARATED FROM COMPRESSOR UNIT ASSEMBLY

FIG. 10

(5) With a hoist, place Accessories Gear Assembly in stand No. Z51,186 for disassembly.



ACCESSORIES GEAR ASSEMBLY AND STAND

FIG. 11

3. DISASSEMBLY OF THE ASSEMBLIES

The turbine engine has now been dismantled into its four major assemblies. Their disassembly will be done in the following order:

THE ACCESSORIES GEAR ASSEMBLY

THE COMPRESSOR UNIT ASSEMBLY

ATTACHED ACCESSORIES

J33 GENERAL ELECTRIC TURBINE ENGINE

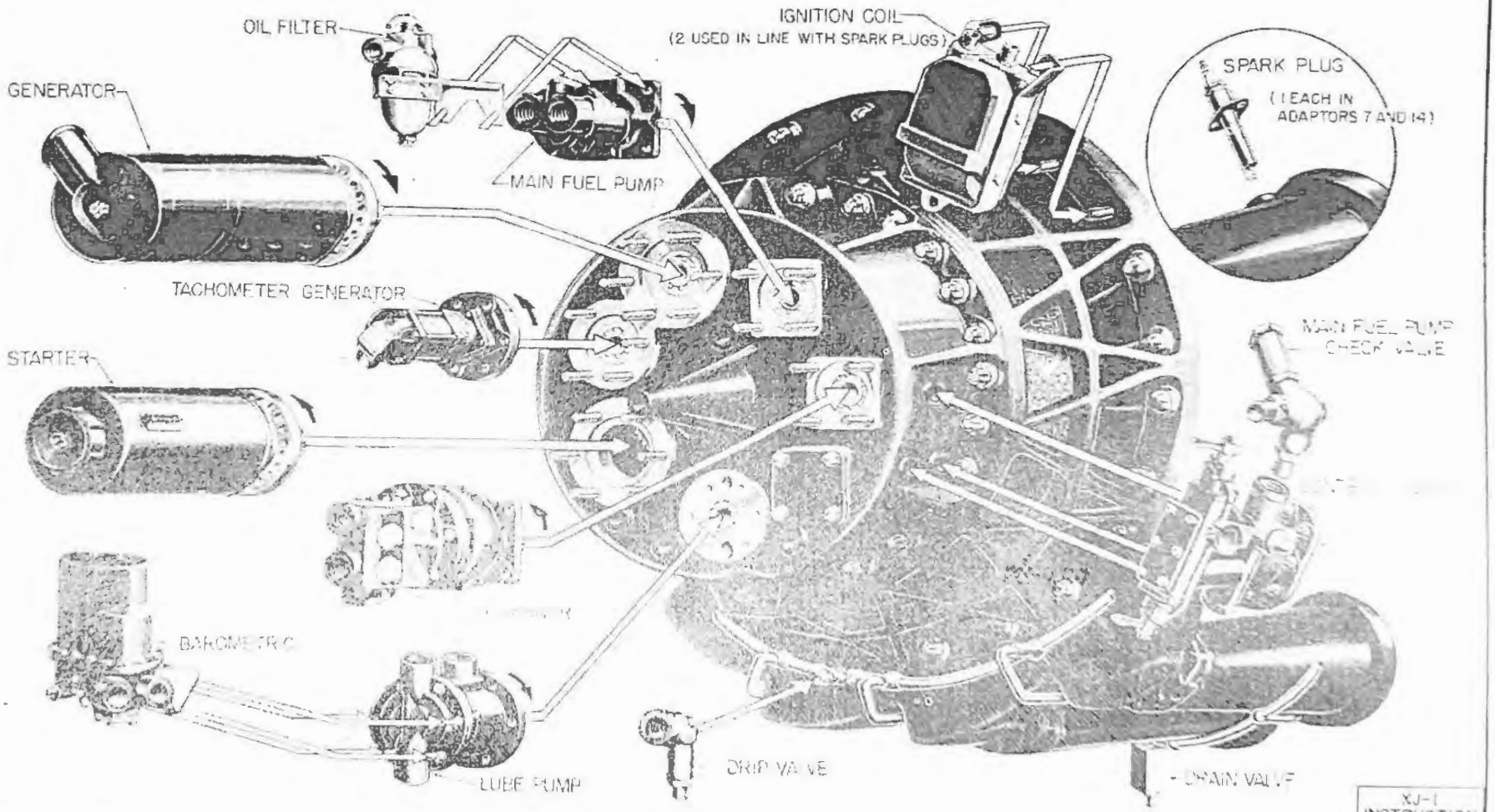


FIGURE 12

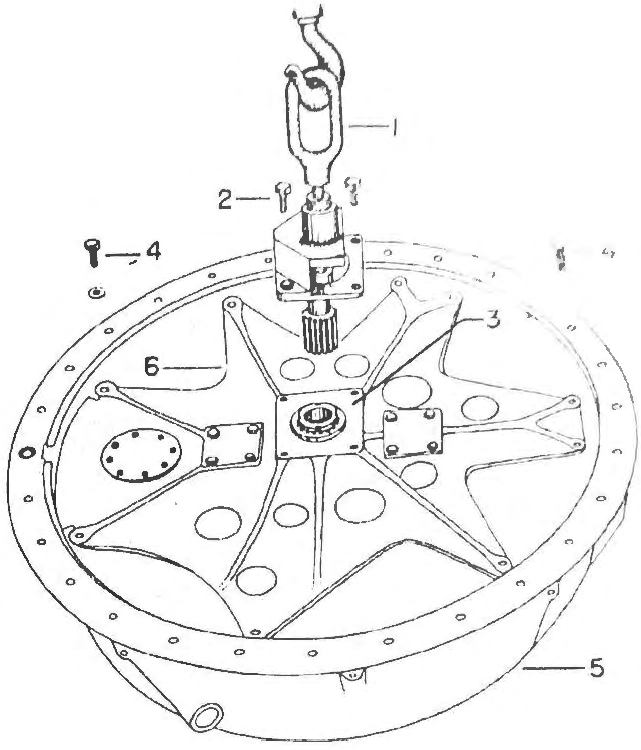
THE TURBINE UNIT ASSEMBLY

THE EXHAUST UNIT ASSEMBLY

a. ACCESSORIES GEAR ASSEMBLY

(1) Remove bearing retainer plate (3) and install Tool No. Z51,215, locking gears in rotor cage assembly, and providing a lifting ring (1), Fig. 13.

(2) Remove safety wire and nine (9) 3/8"-24 x 3-1/2" long cap screws, (2), and seven (7) 3/8"-24 x 1-1/2" long cap screws (4). These secure Rotor Cage Assembly in gear case housing. Using hoist, remove assembly and place in stand No. Z51,189.



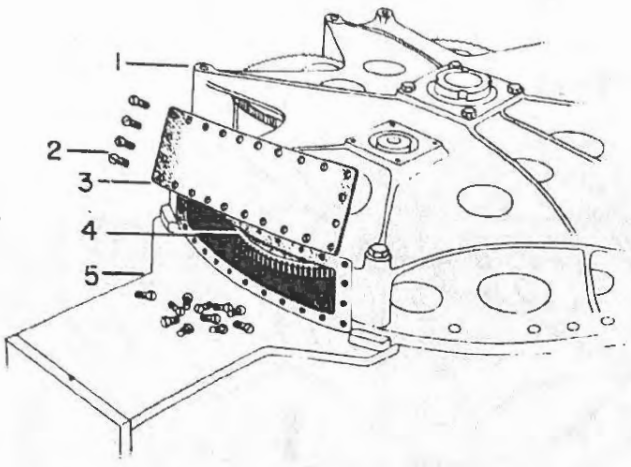
(1) Tool No. Z51,215
(2) Cap Screw
(3) Locking Plate
(4) Cap Screw
(5) Accessories Gear Assembly
(6) Rotor Cage Assembly

REMOVAL OF ROTOR CAGE ASSEMBLY

FIG. 13

(3) Disassembly of the Rotor Cage Assembly.

(a) Rotate stand placing starter gear shaft in vertical position. Remove the twenty-six (26) #6-32 x 3/8" machine screws (3) and remove cover (2) from base of rotor cage (1), Fig. 14.



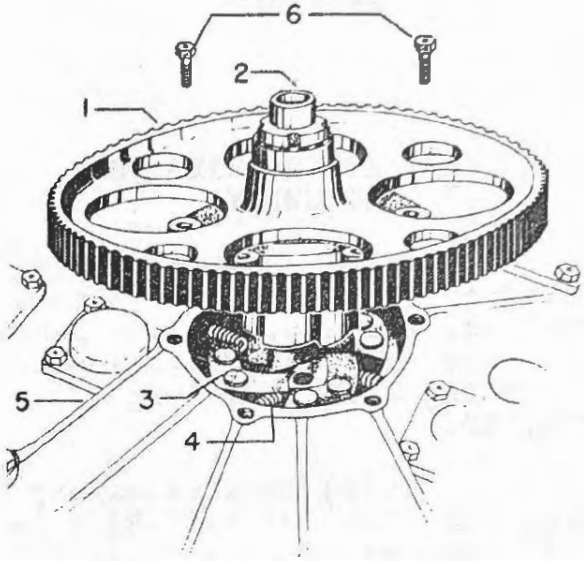
(1) Rotor Cage Assembly
(2) Screw
(3) Cover, Rotor Cage
(4) Lube Pump Drive Gear
(5) Rotor Cage Stand

REMOVAL OF ROTOR CAGE ASSEMBLY COVER

FIG. 14

(b) Remove six (6) 1/4"-20 x 1" long cap screws (1) from starting gear bearing support (2) and remove starting gear assembly from rotor cage (3), Fig. 15.

CAUTION: DO NOT LOSE COIL SPRINGS FROM CLUTCH HUB WHEN REMOVING ASSEMBLY.



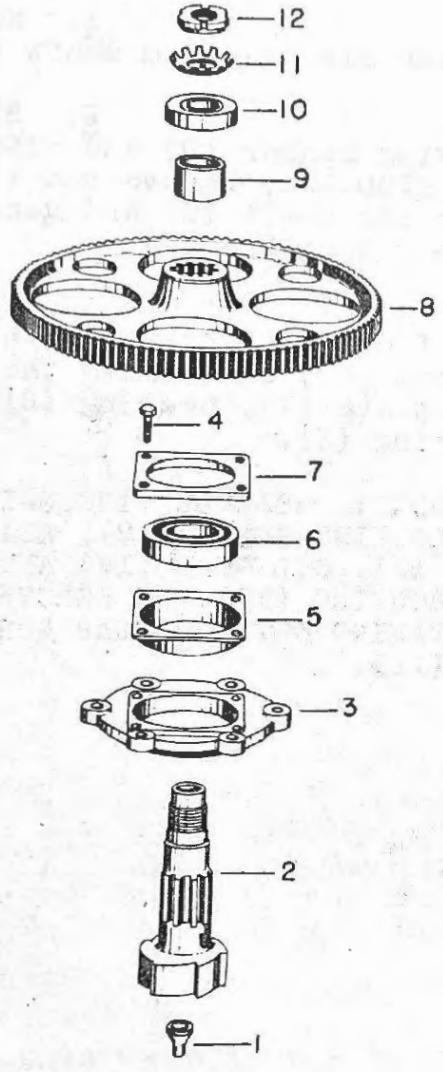
(1) Starter Gear
(2) Starter Gear Shaft
(3) Clutch Pawls
(4) Clutch Springs
(5) Rotor Cage
(6) Cap Screws

REMOVING STARTER GEAR ASSEMBLY FROM ROTOR CAGE

FIG. 15

(c) Disassemble starting gear assembly (Fig. 16).

With starting gear assembly on bench, remove locking nut (12), and disassemble unit, using Tool No. Y51,179.



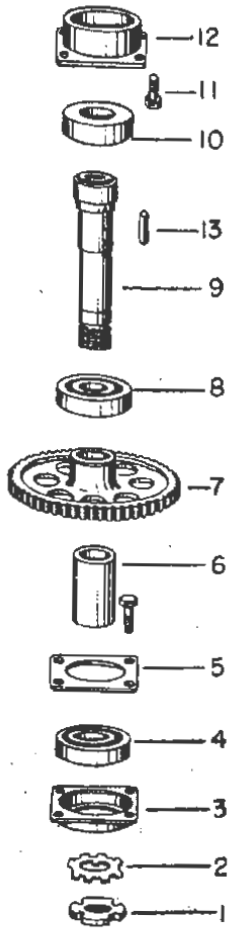
(1) Nozzle
(2) Shaft
(3) Support
(4) Cap Screw
(5) Housing
(6) Bearing
(7) Locking Plate
(8) Gear
(9) Spacer
(10) Bearing
(11) Locking Washer
(12) Locking Nut

STARTER GEAR ASSEMBLY

FIG. 16

(d) Remove starting fuel pump drive assembly, Fig. 17.

1. Loosen locking nut (12). Remove the four (4) 1/4"-20 x 5/8" cap screws (4) from the rear end of gear assembly which secure locking plate (7) and housing (5). Now remove the whole assembly from the rotor cage and disassemble, by first taking off locking nut (12) with Tool No. AD80,094, and remove washer (11) and the rest of assembly as shown in Fig. 17.



(1) Locking Nut
(2) Locking Washer
(3) Housing
(4) Bearing
(5) Bearing Locking Plate
(6) Spacer
(7) Gear
(8) Bearing
(9) Shaft
(10) Oil Seal
(11) Cap Screw
(12) Housing
(13) Key

STARTING FUEL PUMP DRIVE ASSEMBLY

FIG. 17

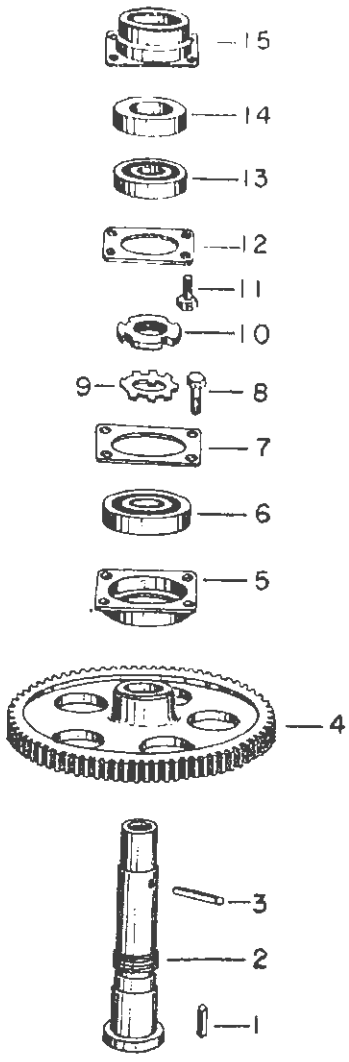
(e) Remove main fuel pump drive assembly, Fig. 18.

1. Remove cotter pin (3) from shaft (2).

2. Straighten locking washer (9) and with Tool No. AD80,094, remove nut (10). Push out shaft (2) and gear (4). Do not drop key (1).

3. Remove the four (4) 1/4"-20 x 5/8" cap screws (8), and remove the locking plate (7), bearing (6) and housing (5).

NOTE: ASSEMBLY INCLUDING LOCKING PLATE (12), BEARING (13), OIL SEAL (14) AND HOUSING (15) ARE REMOVED BY TAKING OUT FOUR CAP SCREWS (11).



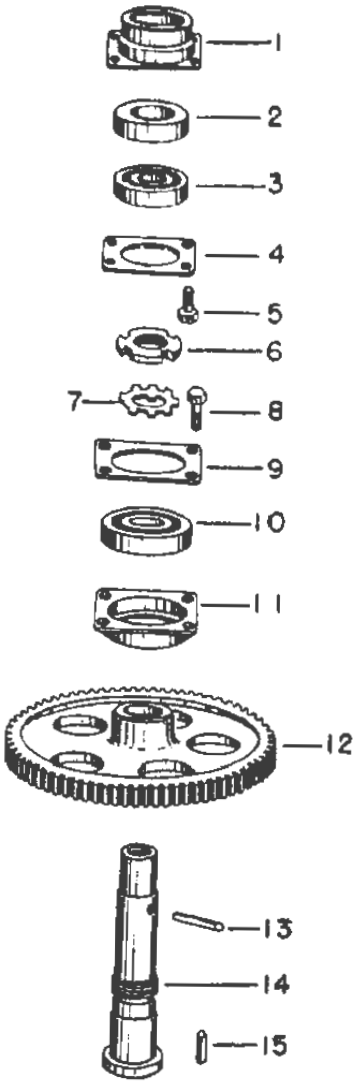
(1) Key
(2) Shaft
(3) Cotter Pin
(4) Gear
(5) Housing
(6) Bearing
(7) Locking Plate
(8) Cap Screw
(9) Locking Washer
(10) Locking Nut
(11) Cap Screw
(12) Locking Plate
(13) Bearing
(14) Oil Seal
(15) Housing

MAIN FUEL PUMP DRIVE ASSEMBLY

FIG. 18

(f) Remove Governor Drive Assembly, Fig. 19.

1. Same procedure is followed as in disassembly of main fuel pump drive assembly.



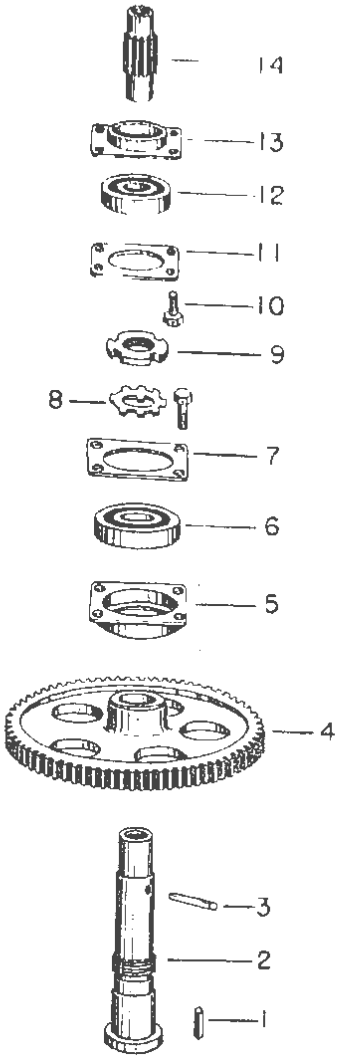
(1) Housing
(2) Oil Seal
(3) Bearing
(4) Locking Plate
(5) Cap Screw
(6) Nut
(7) Locking Washer
(8) Cap Screw
(9) Retaining Plate
(10) Bearing
(11) Housing
(12) Gear
(13) Cotter Key
(14) Shaft
(15) Key

GOVERNOR DRIVE ASSEMBLY

FIG. 19

(g) Remove Tachometer Drive Assembly, Fig. 20.

1. Same procedure is followed as in disassembly of main fuel pump drive assembly.



(1) Key
(2) Shaft
(3) Cotter Pin
(4) Gear
(5) Housing
(6) Bearing
(7) Retaining Plate
(8) Locking Washer
(9) Locking Nut
(10) Cap Screw
(11) Locking Plate
(12) Bearing
(13) Housing
(14) Adapter

TACHOMETER DRIVE ASSEMBLY

FIG. 20

(h) Remove Generator Drive Gear Assembly, Fig. 21.

1. The assembly front bearing housing (13), front ball bearing (12), bearing locking plate (11) and four (4) 1/4"-20 x 5/8" long cap screws (10) are assembled in gear case.

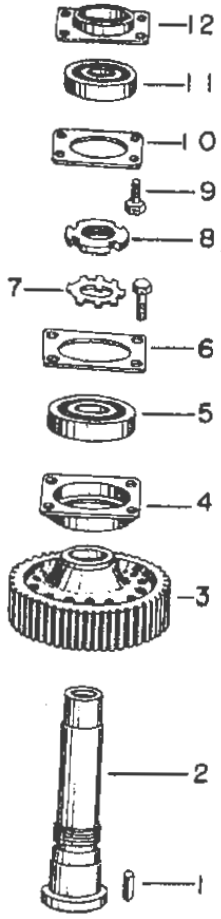
2. Straighten locking washer (8) and with Tool No. AD80,094 remove nut (9). Push shaft (2) out and make sure the gear or key (1) doesn't fall.

3. Take out the four (4) cap screws (3) and the bearing assembly can be removed.

(1) Remove the Lube Pump Drive Gear Assembly Fig. 22.

1. Remove eight (8) #6-32 x 3/8" long screws (16) and lift off cover (17) from rear end of rotor cage (15). Remove oil deflector (6). It is secured with four (4) screws (4). Straighten locking washer (8) and with Tool No. AD80,094 remove the locking nut (7). Push shaft (13) out. Do not drop drive gear (12) or key (14).

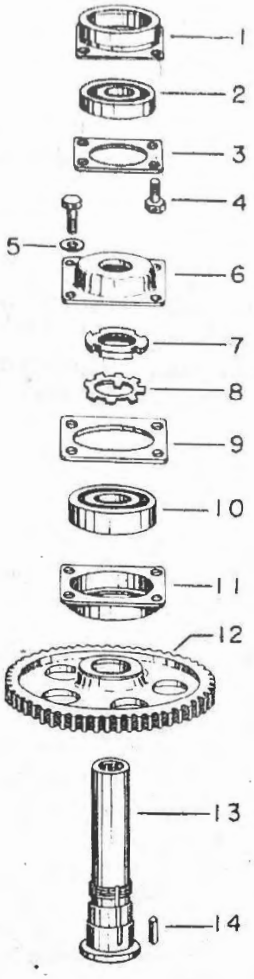
NOTE: THE BEARING ASSEMBLY IS REMOVED BY FIRST TAKING OUT FOUR (4) CAP SCREWS (4) THEN PLATE (9), BEARING (10), AND HOUSING (11). IF THE HOUSING IS TIGHT, TAP OUT WITH A FIBER DRIFT.



(1) Key
(2) Shaft
(3) Gear
(4) Housing
(5) Bearing
(6) Retaining Plate
(7) Locking Washer
(8) Locking Nut
(9) Cap Screws
(10) Locking Plate
(11) Bearing
(12) Housing

GENERATOR DRIVE GEAR ASSEMBLY

FIG. 21



(1) Housing
(2) Bearing
(3) Locking Plate
(4) Cap Screws
(5) Flat Washer
(6) Housing, Oil Deflector
(7) Nut, Locking
(8) Locking Washer
(9) Retaining Plate
(10) Bearing
(11) Housing
(12) Gear
(13) Shaft
(14) Key

LUBE PUMP DRIVE GEAR ASSEMBLY

FIG. 22

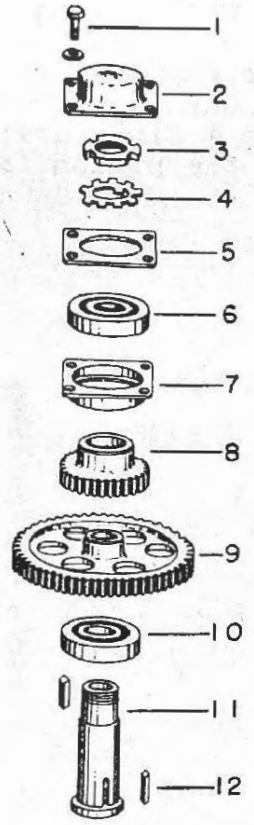
(1) Remove lower idler gear assembly, Fig. 23.

1. Remove safety wire and four (4) cap screws (1) and take off covers (2) and locking plate (5).

2. With spanner wrench remove locking nut (3) and push shaft (11) out. Do not drop any part of the assembly. If the housing (7) is tight, tap out with a fiber drift. Keys (12) are for the pinion (8) and gear (9).

(k) Remove upper idler gear assembly, Fig. 24.

1. Remove four (4) cap screws (1) and locking plate (4). With spanner wrench remove locking nut (2) and push shaft (11) out, holding pinion (7) and gear (8). Do not drop keys (10).



(1) Cap Screw
(2) Front Cover
(3) Locking Nut
(4) Locking Washer
(5) Locking Plate
(6) Bearing
(7) Housing
(8) Pinion
(9) Gear
(10) Bearing
(11) Shaft
(12) Keys

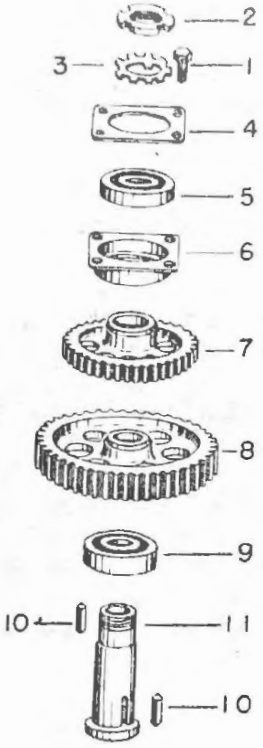
LOWER IDLER GEAR ASSEMBLY

FIG. 23

(1) Remove clutch assembly, Fig. 25.

1. With spanner wrench remove locking nut (1) and push clutch assembly (13) out to front. Remove six (6) screws (11), and take out housing (10), bearing (9), pinion (8), and spacer (7).

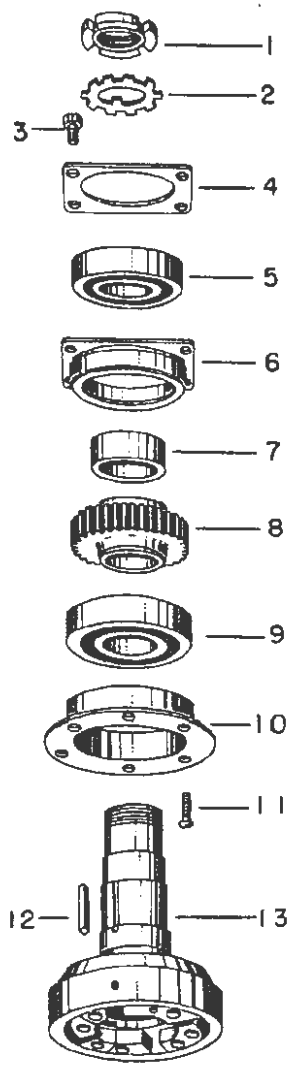
After clutch assembly is out, remove springs, pawls, blocks, and pins. Remove four (4) cap screws (3) and take out locking plate (4), bearing (5) and housing (6).



(1) Cap Screw
(2) Locking Nut
(3) Locking Washer
(4) Locking Plate
(5) Bearing
(6) Housing
(7) Pinion
(8) Gear
(9) Bearing
(10) Keys
(11) Shaft

UPPER IDLER GEAR ASSEMBLY

FIG. 24



(1) Locking Nut
(2) Locking Washer
(3) Cap Screw
(4) Locking Plate
(5) Bearing
(6) Housing
(7) Spacer
(8) Pinion
(9) Bearing
(10) Housing
(11) Screw
(12) Key
(13) Clutch Assembly

CLUTCH ASSEMBLY

FIG. 25

b. COMPRESSOR UNIT ASSEMBLY

(1) Straighten locking washers, (1) Fig. 27, on front and rear impeller shafts.

(2) Loosen the front and rear screens where they are laced together; but do not remove.

(3) Remove front truss ring and bearing support.

(a) Remove safety wire from cap screws and remove screws (2) which hold the adjusting nut (3) to the housing on the front impeller shaft. (Fig. 27)

(b) Install tool, No. Z51,249 over the splined hub of the rear shaft and loosen the lock nuts (4) on the end of each impeller shaft with Tool No. AD80,112 (5). (Fig. 27)

COMPRESSOR BEARING SUPPORT ASSEMBLIES

(WITH RELATED ROTOR PARTS)

J33 GENERAL ELECTRIC TURBINE ENGINE

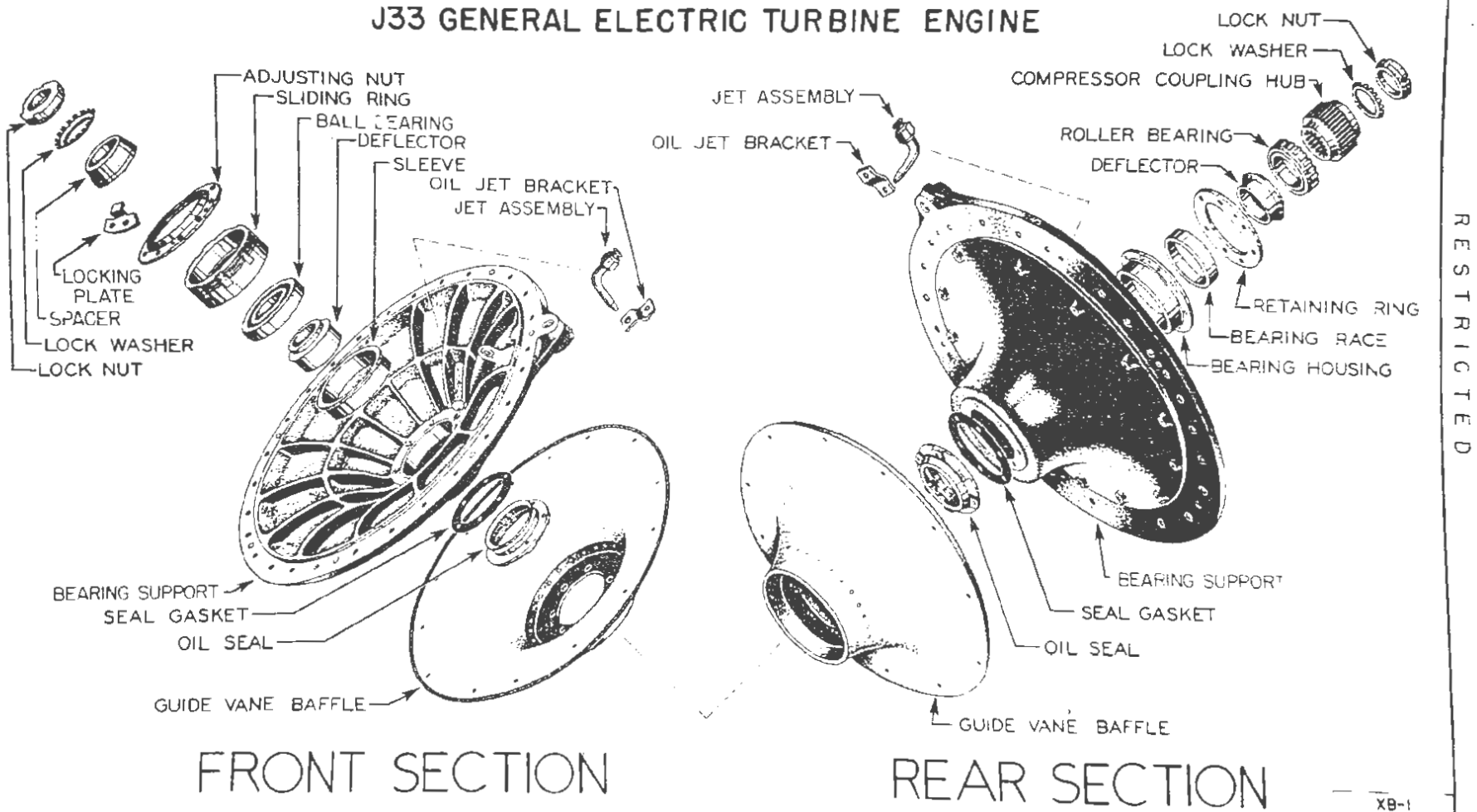
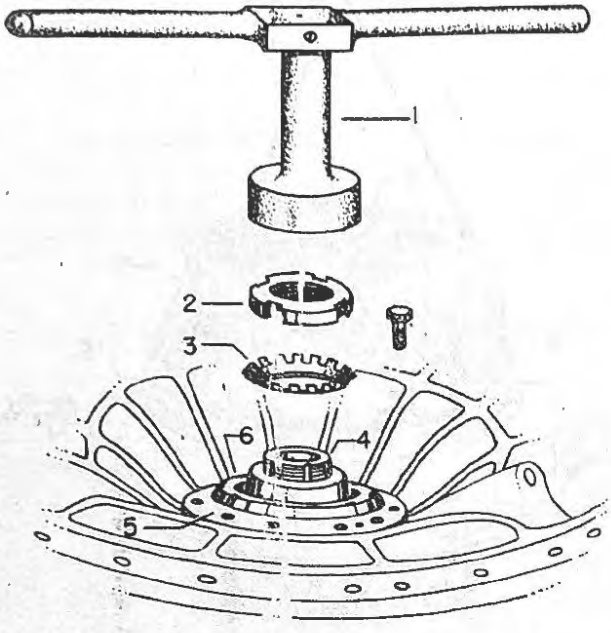


FIGURE 26



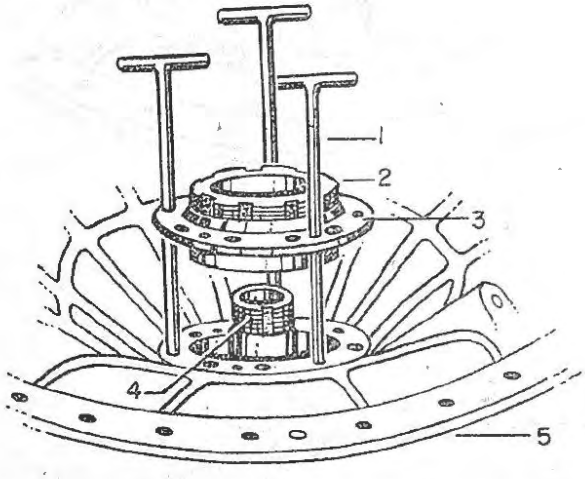
(1) Locking Nut Wrench
(2) Locking Nut
(3) Locking Washer
(4) Front Impeller Shaft
(5) Adjusting Nut
(6) Sliding Ring

ADJUSTING NUT IN FRONT BEARING SUPPORT

FIG. 27

(c) Place stand with rear end of Impeller down, and place jack under the rear impeller shaft, so it will just support impeller assembly. Remove the front bearing retainer nut and washer.

(d) Remove the Adjusting nut and Sliding Ring Assembly with three (3) 5/16"-24 tee handle pullers. (Fig. 28)

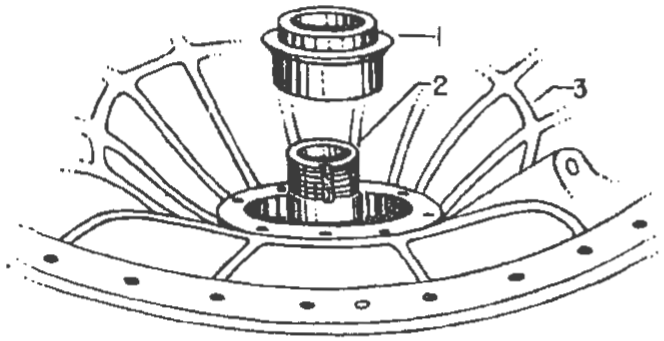


(1) Puller
(2) Sliding Ring
(3) Adjusting Nut
(4) Shaft
(5) Front Bearing Support

REMOVAL OF ADJUSTING NUT AND SLIDING RING ASSEMBLY

FIG. 28

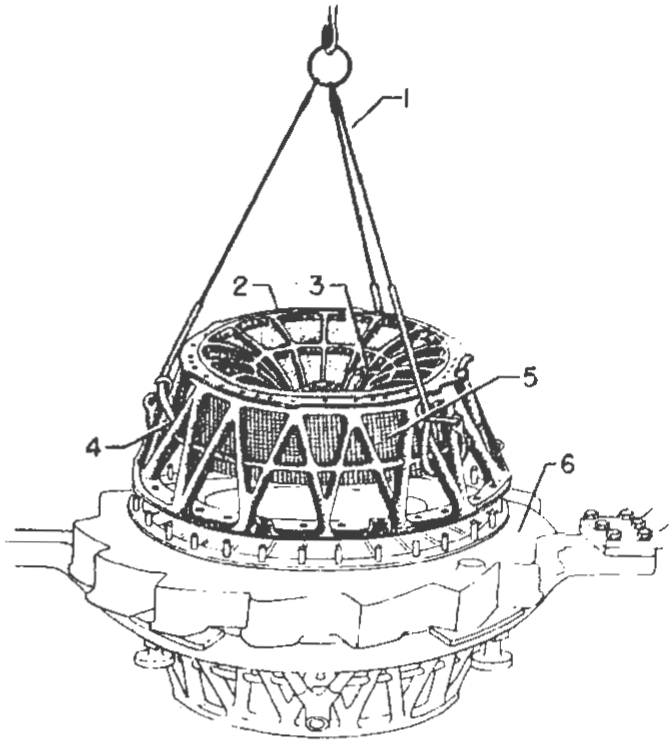
(e) Remove front oil deflector (1) from the impeller shaft (2). Fig. 29.



(1) Oil Deflector
(2) Impeller Shaft
(3) Bearing Support

FRONT OIL DEFLECTOR

FIG. 29



(1) Sling
(2) Bearing Support
(3) Oil Jet Nozzle
(4) Truss Ring
(5) Screen
(6) Diffuser

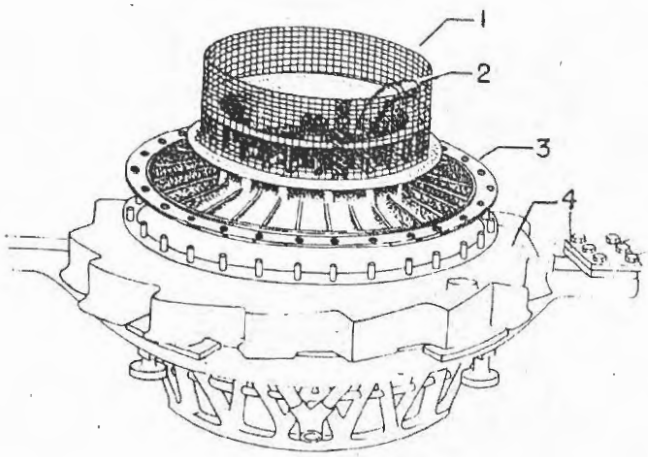
REMOVAL OF TRUSS RING AND BEARING SUPPORT

FIG. 30

(f) Remove cotter keys from the 28, 3/8"-24 nuts, and remove nuts and washers from the studs at compressor and truss ring mounting flanges. Lift truss ring (1) and bearing support (2) from front compressor case (3). Fig. 30.

(g) Remove front bearing support that is held to the front truss ring with seven (7) 5/16"-24 x 5/8" flat head screws.

(h) Remove front compressor case (Fig. 31).



(1) Screen
(2) Generator Cooling Air Tube
(3) Front Compressor Case
(4) Diffuser

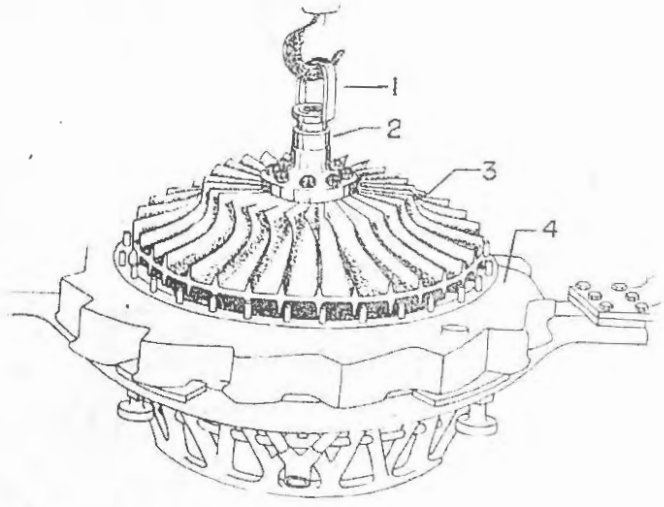
REMOVAL OF FRONT COMPRESSOR CASE

FIG. 31

(4) Remove Impeller.

(a) Remove the retainer nut and washer from the rear impeller shaft. Remove Tool No. Z51,249. Use Tool No. Z51, 206 with short jaws and pull the coupling hub. Remove the rear impeller roller bearing and rear oil deflector.

(b) Install lift ring on the front impeller shaft, and lift the impeller assembly from the rear compressor case. Place in Stand No. Z51,198 Fig. 32.



(1) Lift Ring
(2) Front Shaft
(3) Impeller
(4) Diffuser

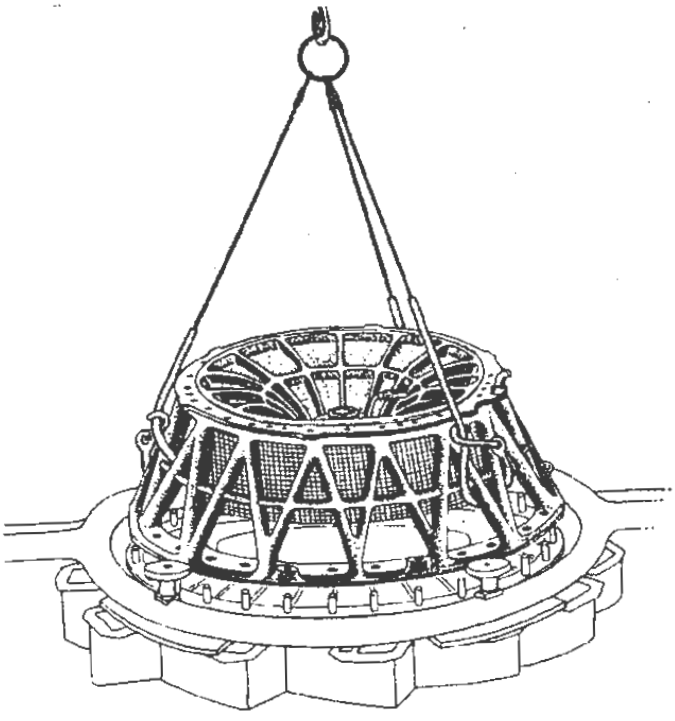
REMOVAL OF IMPELLER ASSEMBLY

FIG. 32

(5) Remove rear compressor case.

(a) Remove cotter keys from the twenty-eight (28) 3/8"-24 nuts, and remove nuts and washers from the studs at compressor and truss ring mounting flanges. Lift truss ring and bearing support from the rear compressor case.

(b) Remove rear bearing support that is held to the rear truss ring with seven (7) 5/16"-24 x 5/8" flat head screws. Remove rear compressor case. (Fig. 33)

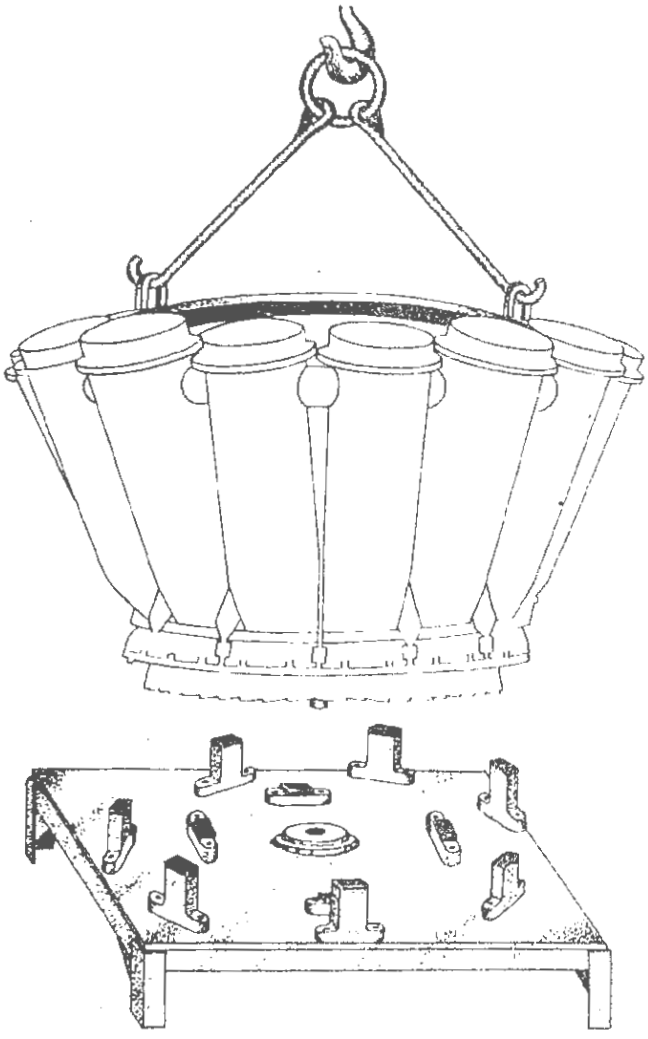


REMOVAL OF REAR TRUSS RING AND BEARING SUPPORT

FIG. 33

o. TURBINE UNIT ASSEMBLY

(1) Turn stand until Turbine wheel is at the bottom and attach Sling No. Z51,169 to the fixture on the ring mounting flange, and place assembly in turbine stand No. Z51,252 (Fig. 34).



TURBINE UNIT ASSEMBLY AND TURBINE STAND

FIG. 34

(a) Remove the Front Oil Jet Assembly.

(2) Place jack under turbine.

(3) With holding device No. Z51,247 installed over turbine shaft, loosen and remove the retainer nut with Tool No. AD80,112. Use Tool No. Z51,206 with the long jaws, remove the coupling sleeve.

(4) Remove Adjusting Nut and Sliding Ring Assembly with three (3) 5/16"-24 tee handle pullers. By use of jack, lower turbine until it rests on turbine stand.

(5) Lift ring and tube and bearing assemblies from off the turbine shaft. Place back in Stand No. Z51,196.

CAUTION: INSTALL PROTECTIVE SLEEVE #Y51,243 OVER TURBINE SHAFT BEFORE REMOVING RING AND TUBE ASSEMBLY.

(6) Remove nut and washer, spacer, bearing and oil deflector from shaft.

(7) Invert stand until the rear end of bearing support is up.

(8) Remove the seven (7) 1/4"-28 x 3/4" long cap screws from the diffuser and remove diffuser from assembly. Remove the six (6) #10-32 x 7/16" long cap screws holding oil seal to the diffuser and remove oil seal and gasket.

TURBINE BEARING SUPPORT ASSEMBLIES

(WITH RELATED ROTOR PARTS)

J33 GENERAL ELECTRIC TURBINE ENGINE

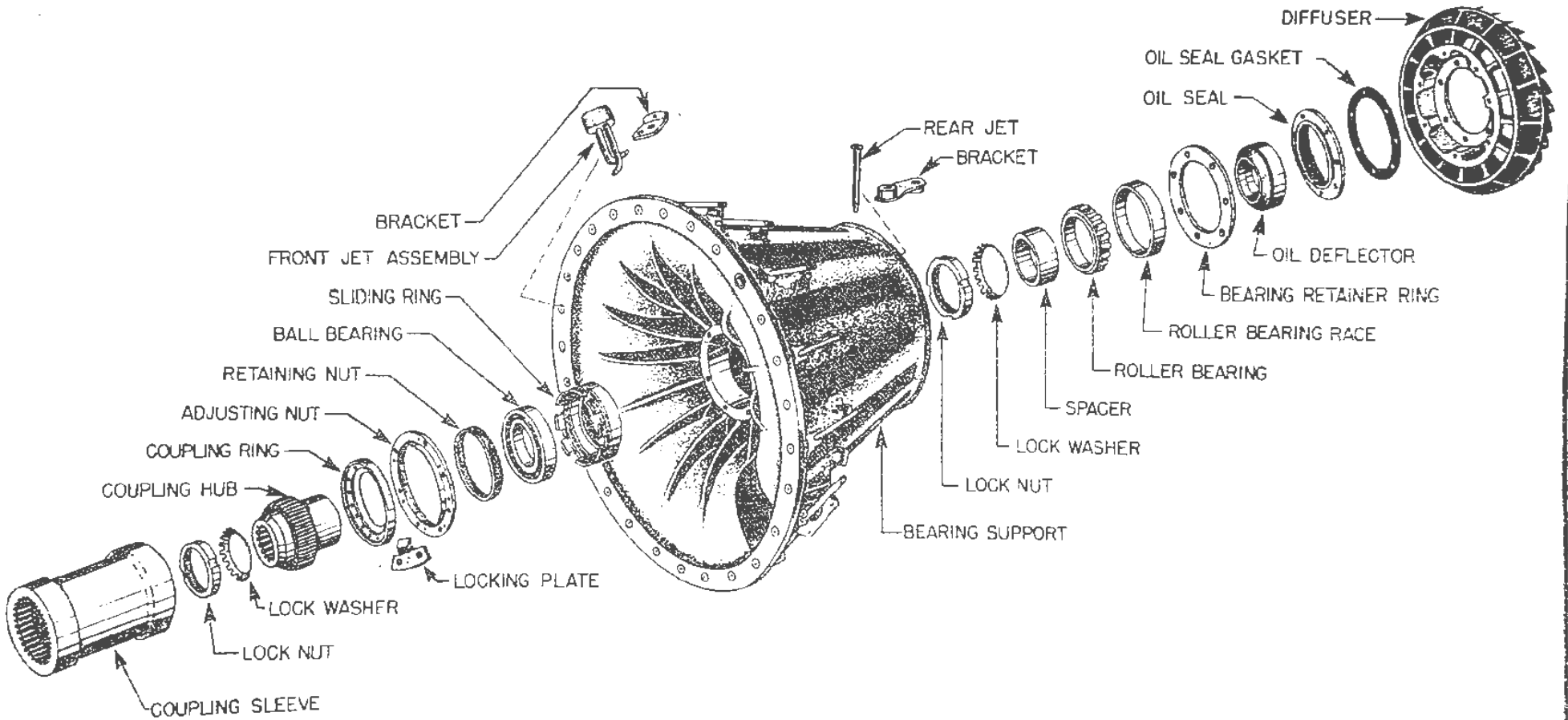
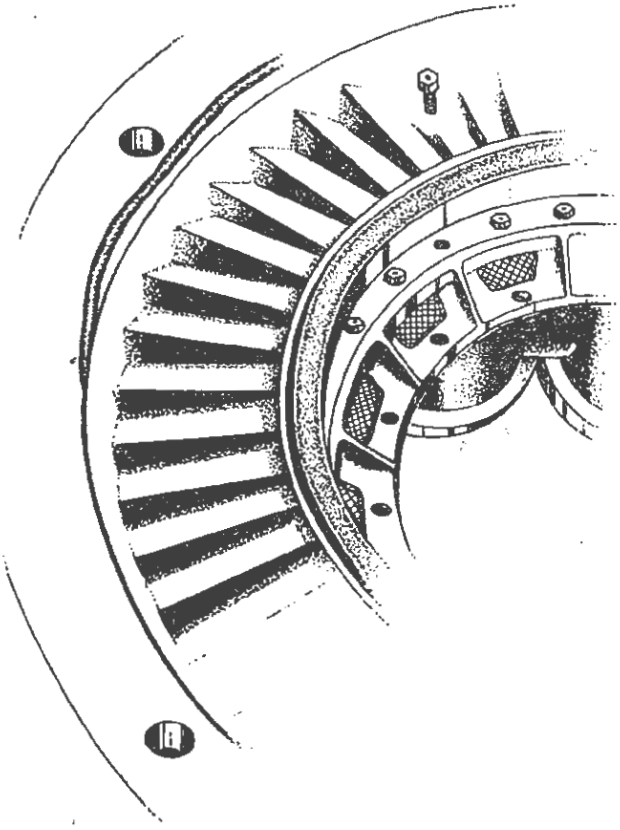


FIGURE 35

(9) Remove the asbestos packing from around the Nozzle Diaphragm. (A bent scribe is helpful for this.) Remove the twenty-eight (28) 5/16"-24 x 5/8" cap screws from Nozzle Diaphragm and lift out Diaphragm. (Fig. 36)

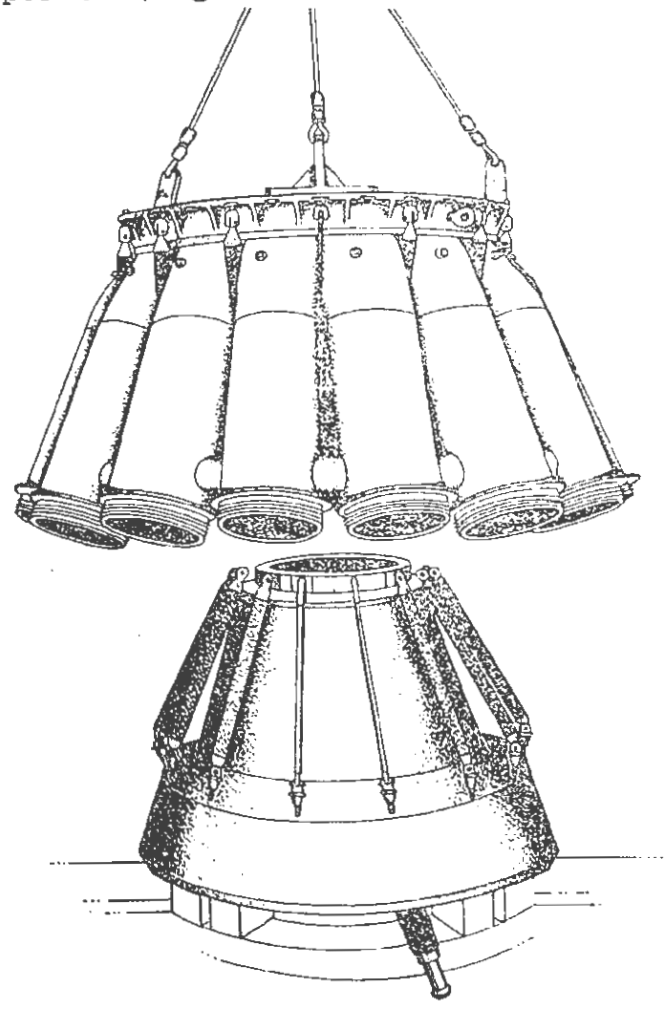


REMOVAL OF NOZZLE DIAPHRAGM

FIG. 36

(10) Remove the fourteen (14) 5/16"-24 x 5/8" cap screws, from the mounting flange of the Turbine Bearing Support to Ring and Tube assembly.

(11) Install two lift rings, to ring mounting flange and hoist the Ring and Tube Assembly from the Rear Bearing Support. (Fig. 37)



REMOVAL OF RING AND TUBE ASSEMBLY

FIG. 37

(a) Remove thermocouples from bearing housing and withdraw leads from bearing support.

(b) Remove shrouding from Rear Bearing Support, after removing fourteen (14) tie-strap assemblies and cap screws.

(c) Remove Rear Bearing Oil Jet.

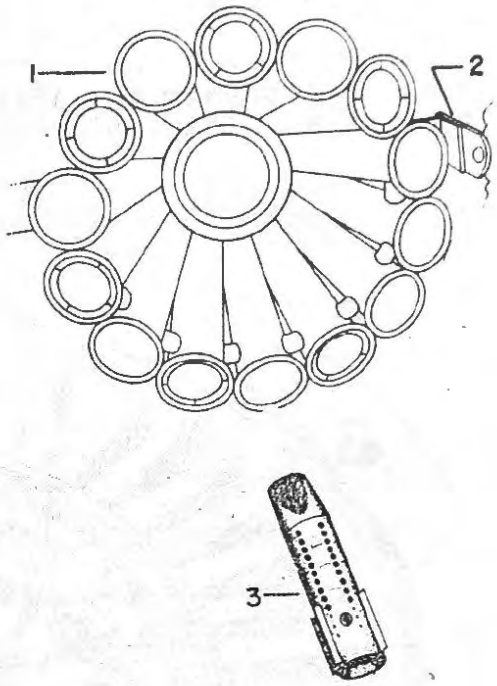
(d) Remove the seven (7) 1/4"-28 x 3/4" long cap screws from bearing housing and remove retaining ring. With three (3) tee handled pullers remove bearing housing and outer race from the Rear Bearing Support.

(12) Place Ring and Tube Assembly on a bench with rear end up. Remove lift rings and turn the assembly over, with the front end up.

(13) Remove the set screws at the rear, which hold flame tubes in the outer Tube Assembly. Cut the safety wire from Inner Crossover Tubes, and push them into the even numbered flame tubes, 2, 4, 6, etc.

(14) With a pair of pliers, pull the odd numbered flame tubes from Outer Tube Assembly.

(15) Remove the Inner Crossover Tubes from remaining flame tubes and pull flame tubes from Outer Tube Assembly. (Fig. 38)



(1) Ring and Tube
(2) Stand
(3) Flame Tube

REMOVAL OF FLAME TUBES

FIG. 38

d. EXHAUST UNIT ASSEMBLY.

NOTE: THIS UNIT WILL NOT BE DISASSEMBLED.

TURBINE BEARING SUPPORT ASSEMBLIES

(WITH RELATED ROTOR PARTS)

J33 GENERAL ELECTRIC TURBINE ENGINE

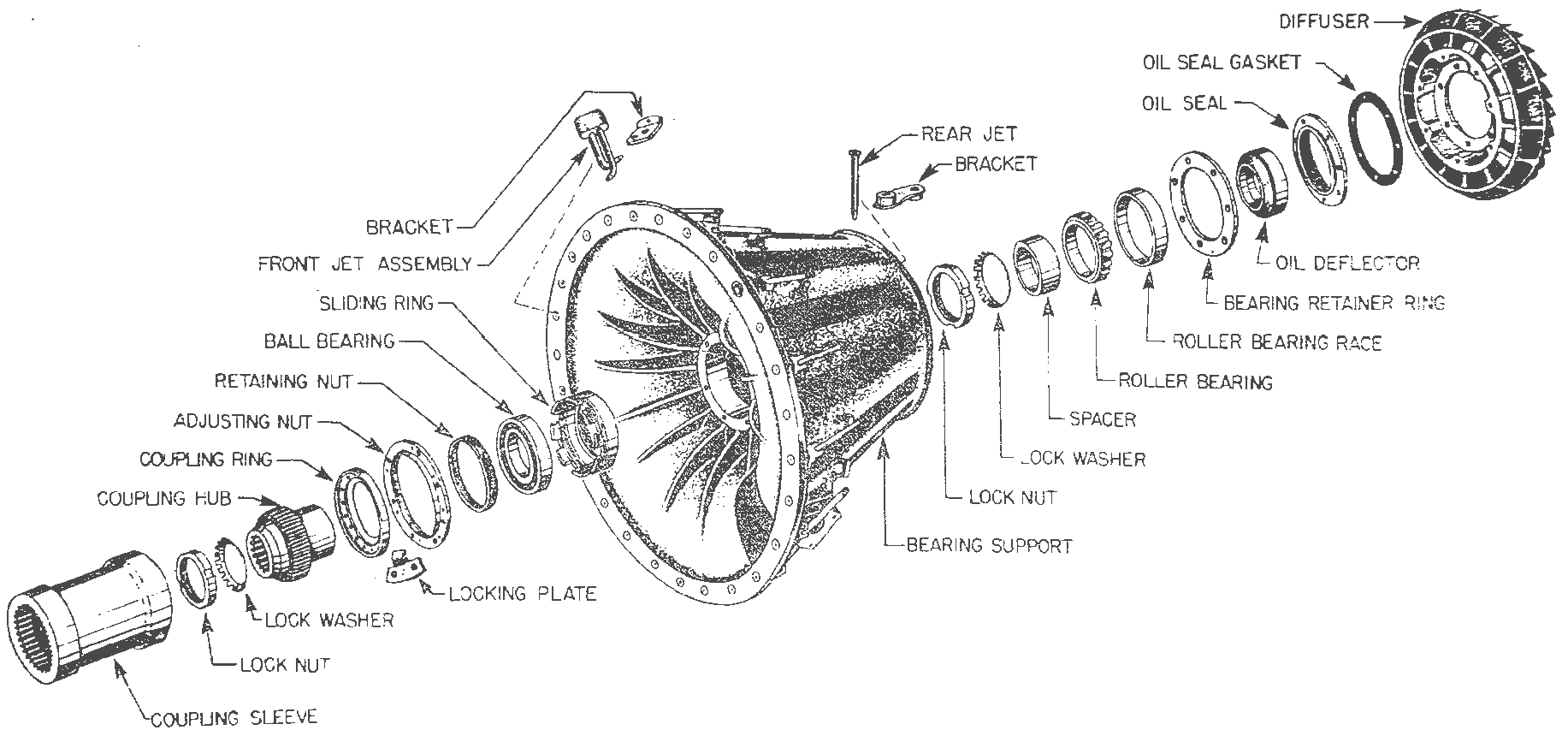


FIGURE 35

R E S T R I C T E D

I N D E X T O S E C T I O N 4

J33 T U R B I N E E N G I N E

B U I L D-U P O F S U B-A S S E M B L I E S

A N D

F I N A L A S S E M B L Y

R E S T R I C T E D

S E C T I O N 4

J33 T U R B I N E E N G I N E

B U I L D-U P O F S U B-A S S E M B L I E S

A N D

F I N A L A S S E M B L Y

The major assemblies of the J33 engine are built as four separate and individual assemblies.

They are, in the order of their build-up:

Accessories Gear Assembly.
Compressor Unit Assembly.
Turbine Unit Assembly
Exhaust Unit Assembly

Reference to the section containing the Table of Limits is essential to insure correct torque and clearances.

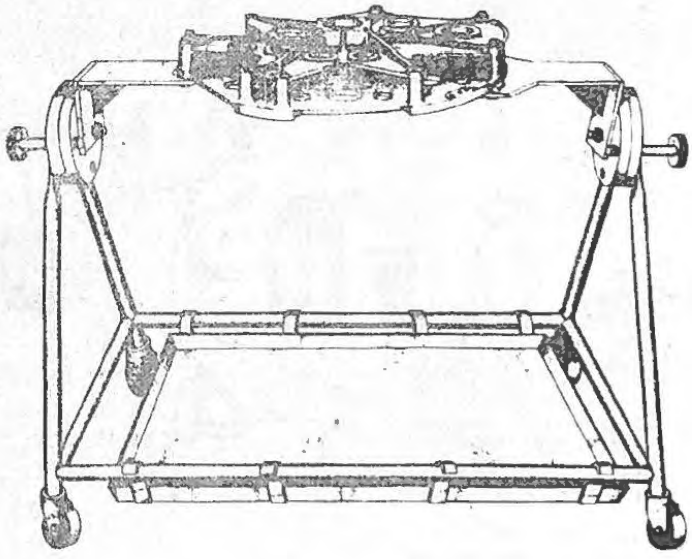
1. BUILD-UP MAJOR ASSEMBLIES

a. ACCESSORIES GEAR ASSEMBLY

The component parts of the accessory drives are built into the rotor cage, and then installed as a unit into the gear casing.

(1) Assemble rotor cage and gear train.

(a) Place rotor cage in stand No. Z51,189 and use the following procedure to assemble the gear trains. (Fig. 1)



ROTOR CAGE IN STAND

FIG. 1

(b) Install clutch assembly. (Fig. 2)

1. Build clutch assembly.

a. Install bearing (5), key (11), pinion (8), and spacer (7) on clutch shaft (12).

2. Turn cage to vertical position.

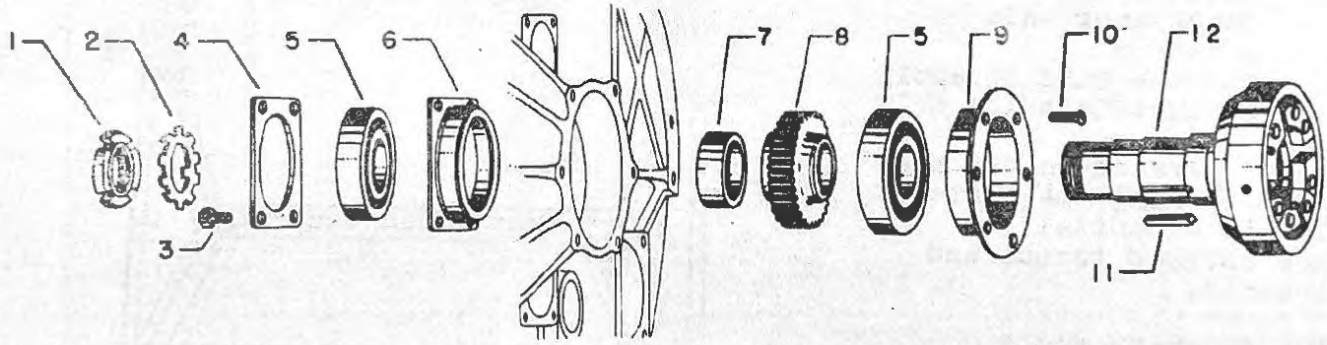
3. Install front bearing housing (9).

4. Install rear bearing housing (6).

5. Install clutch assembly so bearing (5) is seated in front housing (9). Place rear bearing (5) over shaft and seat in housing (6). Install rear bearing clamping plate (3), and secure with four (4) 1/4-20x5/8" hex head cap screws.

a. Install clutch shaft locking washer (2) and locking nut (1).

6. Secure front bearing housing (9) with six (6) 10-24x5/8" fillister head screws.



(1) Locking Nut
(2) Locking Washer
(3) Bearing Clamping Plate
(4) Cap Screw
(5) Ball Bearing
(6) Rear Bearing Housing
(7) Spacer
(8) Pinion
(9) Front Bearing Housing
(10) Screw
(11) Key
(12) Clutch Assembly

CLUTCH ASSEMBLY TO ROTOR CAGE

FIG. 2

(c) Install starting gear assembly. (Fig. 3)

1. Build starting gear assembly.

a. Install rear bearing housing (8) into bearing support (9), and insert bearing (3). Secure in place with locking plate (7) and four 1/4-20x5/8" hex head cap screws (6).

b. Install shaft (10) into bearing (3).

c. Place starting gear (5), spacer (4), and bearing (3) on shaft. Secure with locking washer (2) and locking nut (1).

NOTE: GEAR IS INSTALLED WITH LONG HUB TO THE FRONT

2. Install starting gear assembly.

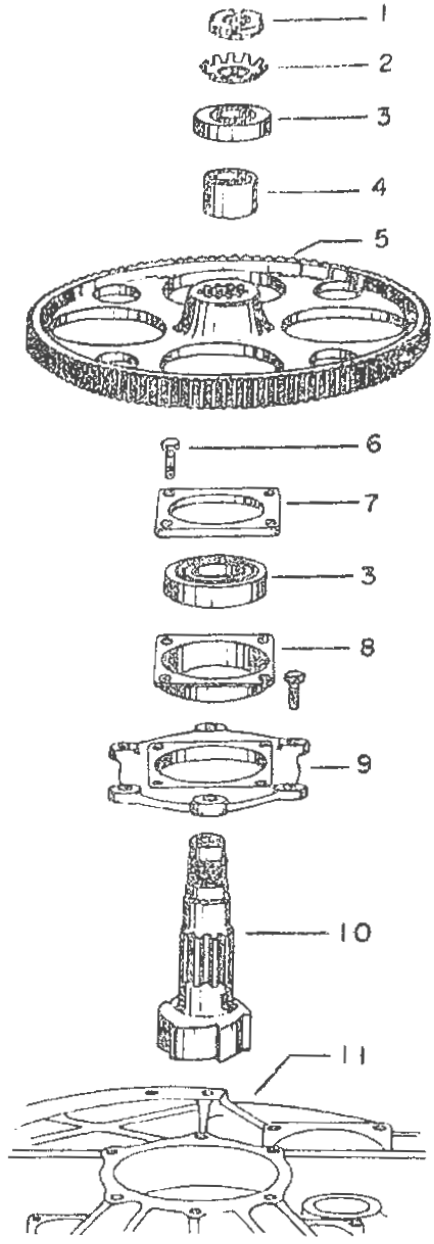
a. Place starting gear assembly into the rotor cage, so that ratchet of starting gear engages with pawls of clutch assembly.

b. Secure in place with six (6) 1/2"-20x7/8" hex head cap screws and plain washers.

(d) Assemble lower idler gear and pinion. (Fig. 4)

1. Install rear bearing housing (6) into rotor cage.

2. Place bearing (5) on shaft (4) and push shaft through the rear bearing housing (6).



(1) Locking Nut
(2) Locking Washer
(3) Ball Bearing
(4) Spacer
(5) Starting Gear
(6) Cap Screw
(7) Locking Plate
(8) Bearing Housing
(9) Bearing Support
(10) Starter Gear Shaft
(11) Rotor Cage

STARTING GEAR ASSEMBLY TO ROTOR CAGE

FIG. 3

3. Place the lower key (3) into position on shaft (4). Place both gear (7) and pinion (8) in rotor cage and over shaft (4). Start gear (7) on to key (5). Install bearing (5) into housing (6), and press gear (7) until its hub seats against the bearing. Install pinion key into slot on shaft (4) and key way of pinion (8).

NOTE: GEAR IS PLACED ON SHAFT, WITH LONG HUB TO REAR. PINION IS PLACED ON SHAFT, WITH LONG HUB TO FRONT.

4. Install front bearing housing (10) into the rotor cage, and press bearing (5) into place over shaft (4).

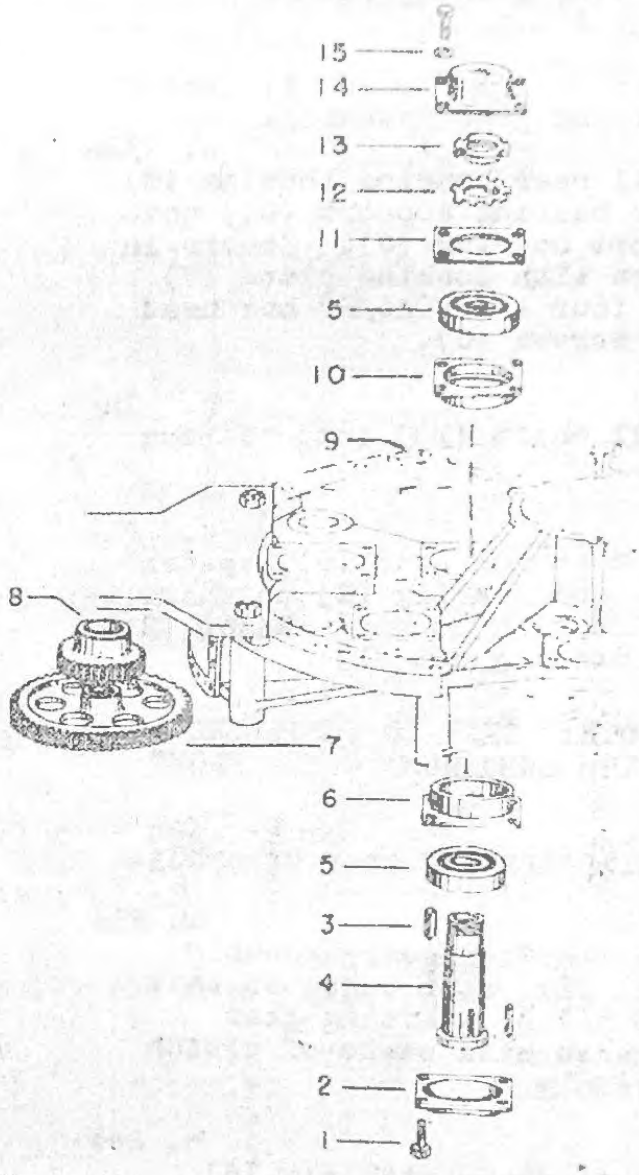
5. Install locking washer (12) and locking nut (13).

6. Attach the locking plate (11) front cover (14) and bearing housing (10) to rotor cage, with four (4) 1/4"-20x3/4" hex head cap screws.

7. Secure the rear bearing housing and cover to the rotor cage with four (4) 1/4"-20x5/8" hex head cap screws (1) and plain washers (15).

(e) Assemble upper idler gear and pinion. (Fig. 5)

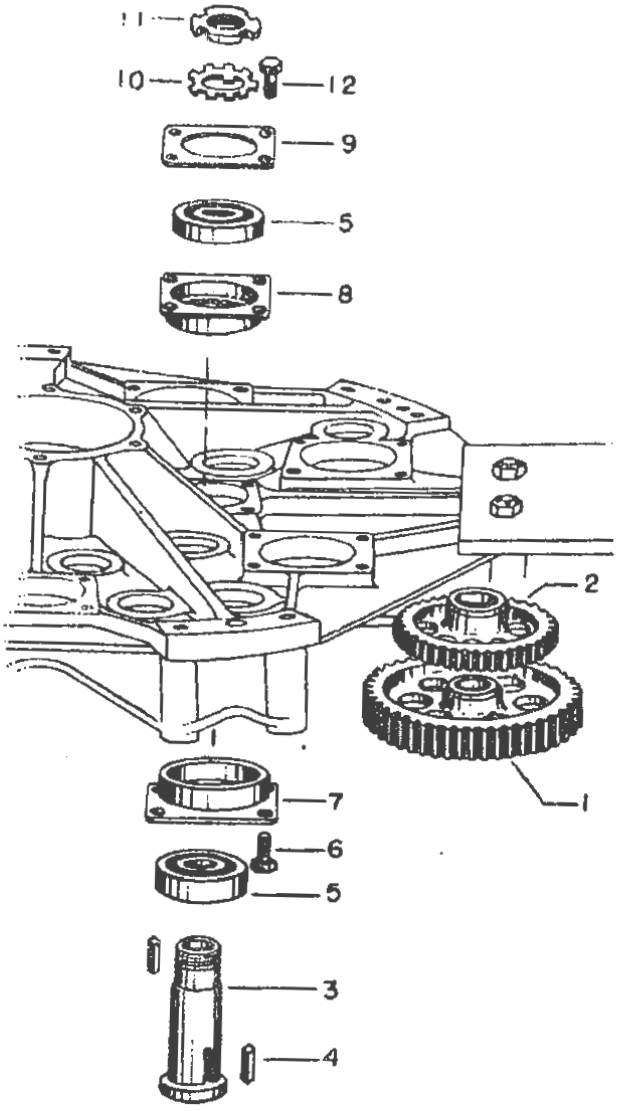
1. Install rear bearing housing (7) into rotor cage, and secure with four (4) 1/4"-20x5/8" cap screws (6) and plain washers (13).



(1) Cap Screw
(2) Rear Shaft Cover
(3) Key
(4) Shaft
(5) Bearing
(6) Rear Bearing Housing
(7) Lower Idler Gear
(8) Lower Idler Pinion
(9) Rotor Cage
(10) Front Bearing Housing
(11) Locking Plate
(12) Locking Washer
(13) Locking Nut
(14) Front Shaft Cover
(15) Plain Washer

LOWER IDLER GEAR AND PINION ASSEMBLY TO ROTOR CAGE

FIG. 4



(1) Gear
(2) Pinion
(3) Shaft
(4) Key
(5) Bearing
(6) Cap Screw
(7) Rear Bearing Housing
(8) Front Bearing Housing
(9) Bearing Locking Plate
(10) Locking Washer
(11) Locking Nut
(12) Cap Screw
(13) Plain Washer

UPPER IDLER GEAR AND PINION ASSEMBLY
FIG. 5

2. Place bearing (5) on shaft (3) and push shaft through the bearing housing (7).

3. Place the lower key (4) into position on shaft (3). Start gear (1) on the key (4). Install bearing (5) into housing (7), and press gear (1) until its hub seats against the bearing. Install upper key into slot on shaft (3) and key way of pinion (2).

NOTE: GEAR IS PLACED ON SHAFT, WITH LONG HUB TO REAR. PINION IS PLACED ON SHAFT, WITH LONG HUB TO FRONT.

4. Install front bearing housing (8) into the rotor cage and press bearing (5) into place over shaft (3).

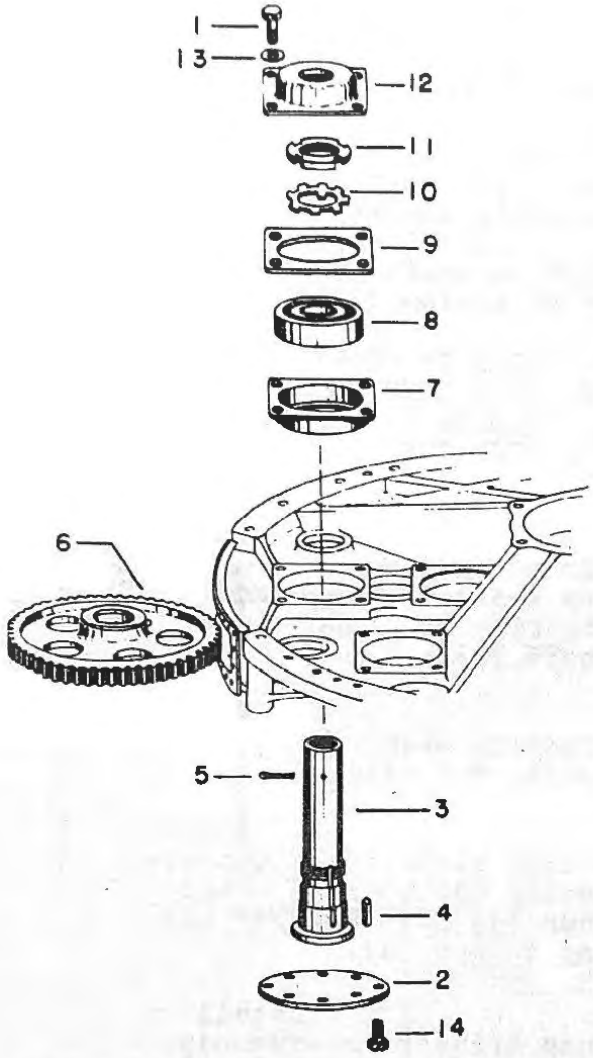
5. Install locking washer (10) and locking nut (11).

6. Attach the locking plate (9) and bearing housing (8) to rotor cage with four (4) 1/4"-20x3/4" hex head cap screws (6).

(f) Install lube pump drive gear assembly. (Fig. 6)

1. Place bearing housing (7) in rotor cage and install bearing (8).

2. Hold lube pump drive gear inside of rotor cage and install shaft (3) with key in place, through the bearing (8) and gear (6).



(1) Cap Screw
(2) Rear Cover
(3) Shaft
(4) Key
(5) Cotter Pin
(6) Gear
(7) Bearing Housing
(8) Bearing
(9) Bearing Retaining Plate
(10) Locking Washer
(11) Locking Nut
(12) Oil Deflector
(13) Washer
(14) Screw

LUBE PUMP DRIVE GEAR ASSEMBLY

FIG. 6

NOTE: LONG HUB OF GEAR IS PLACED TO FRONT

3. Install locking washer (10) and locking nut (11).

4. Place bearing retaining plate (9) and deflector (12) over shaft (3), and secure with four (4) 1/4"-20x5/8" hex head cap screws (1), and plain washers (13).

5. Place cover (2) over opening in rear of rotor cage. Secure with eight (8) No. 6-32x3/8" screws (14). Lock with wire.

(g) Install tachometer generator drive assembly. (Fig. 7)

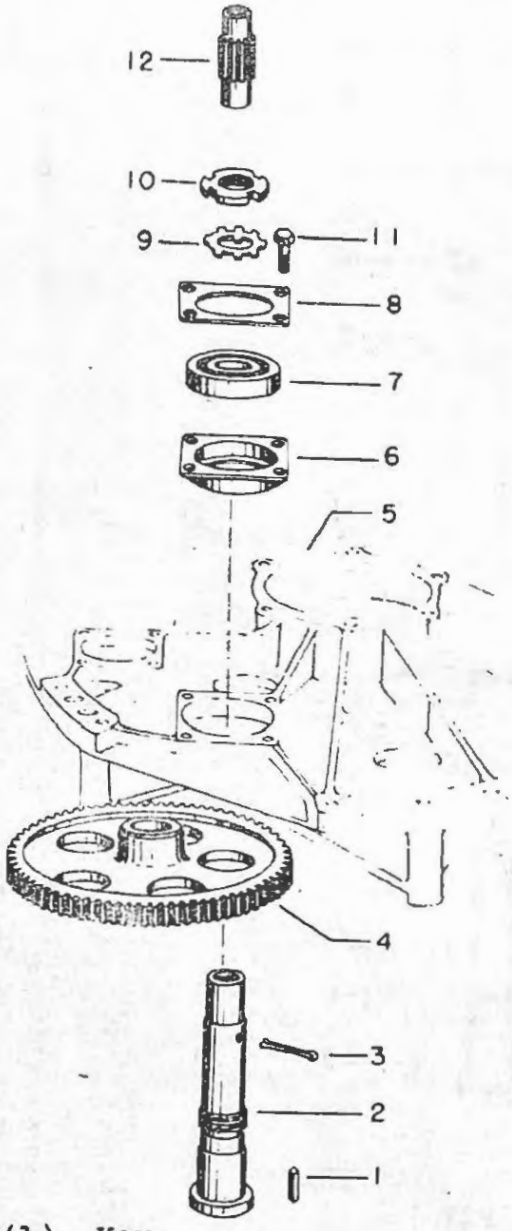
1. Install rear bearing housing (6) into rotor cage and install bearing (7).

2. Insert key (1) into shaft (2) and install gear (4). Place shaft into bearing (7) until it seats properly. Install locking washer (9) and locking nut (10).

NOTE: PLACE LONG HUB OF GEAR TO THE FRONT

3. Install bearing retaining plate (8) and secure with four (4) 1/4"-20x5/8" cap screws (11).

4. Insert accessory drive adapter (12) into shaft and hold with cotter pin.



(1) Key
(2) Shaft
(3) Cotter Pin
(4) Gear
(5) Rotor Cage
(6) Bearing Housing
(7) Bearing
(8) Bearing Retaining Plate
(9) Locking Washer
(10) Locking Nut
(11) Cap Screw
(12) Drive Adapter

TACHOMETER GENERATOR DRIVE ASSEMBLY

FIG. 7

(h) Install main fuel pump drive assembly. (Fig. 8)

1. Install accessory rear bearing housing (5) into cage and install bearing (6).

2. Insert key (2) into shaft (1) and install gear (4). Place shaft into bearing (6) until it seats properly. Install locking washer (9) and locking nut (10).

NOTE: INSTALL GEAR WITH LONG HUB TO THE FRONT

3. Install bearing retaining plate (7), and secure with four (4) 1/4"-20x5/8" cap screws (8).

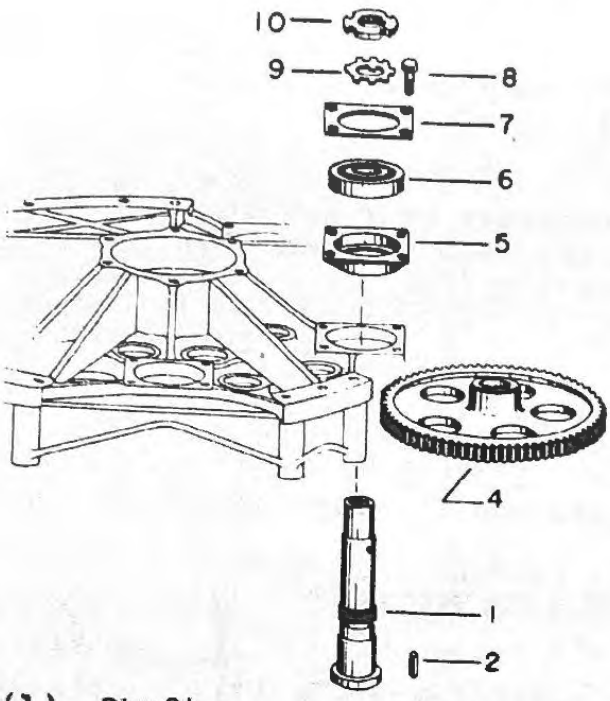
(i) Install governor drive assembly. (Fig. 9)

1. Install rear bearing housing (6) into rotor cage, and install bearing (7).

2. Insert key (2) into shaft (1) and install gear (4). Place shaft into bearing (7) until it seats properly. Install locking washer (10) and locking nut (11).

NOTE: PLACE LONG HUB OF GEAR TO FRONT

3. Install bearing retaining plate (8) and secure with four (4) 1/4"-20x5/8" cap screws (9).



(1) Shaft
(2) Key
(3) Cotter Pin
(4) Gear
(5) Bearing Housing
(6) Bearing
(7) Bearing Retaining Plate
(8) Cap Screw
(9) Locking Washer
(10) Locking Nut

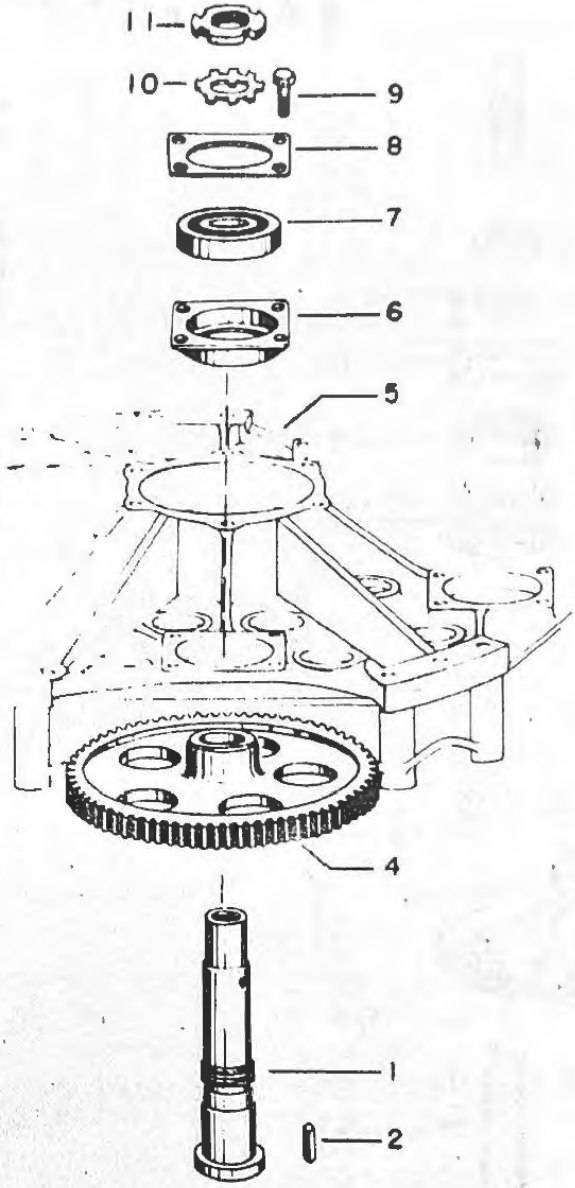
MAIN FUEL PUMP DRIVE ASSEMBLY

FIG. 8

(j) Install starting fuel pump drive assembly. (Fig. 10)

1. Install accessory bearing housing (3) and bearing (4) into rotor cage. Secure with bearing retaining plate (5), four (4) 1/4"-20x5/8" hex head cap screws.

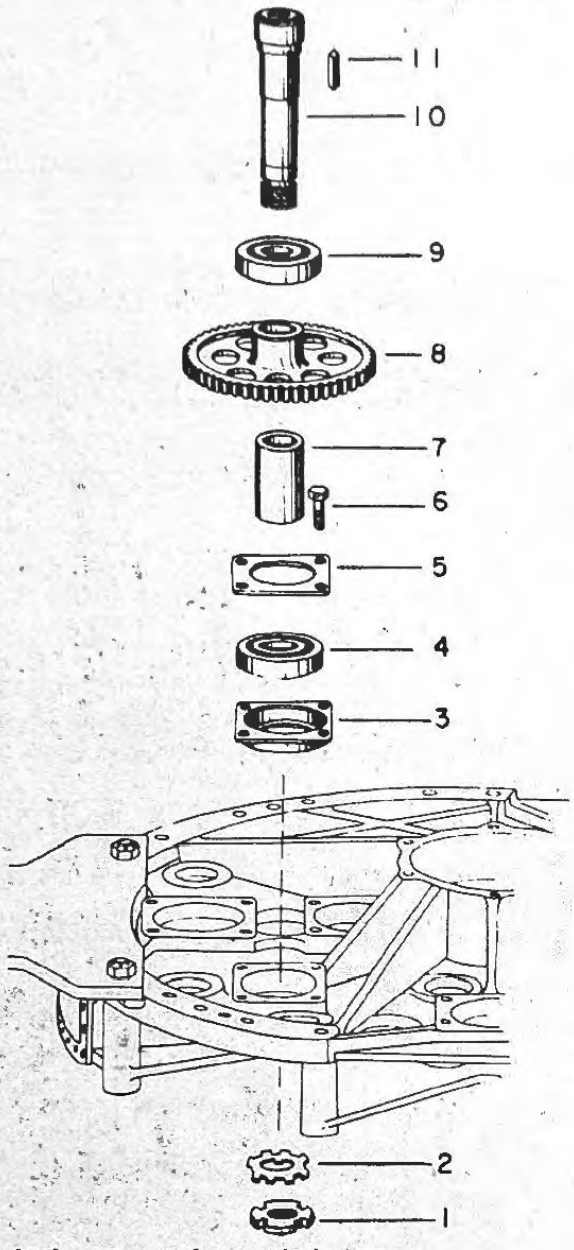
2. Install front bearing (9) on shaft assembly (10), place key (11) into key way on shaft and install drive gear (8) and spacer (7).



(1) Shaft
(2) Key
(3) Cotter Pin
(4) Gear
(5) Rotor Cage
(6) Bearing Housing
(7) Ball Bearing
(8) Bearing Retaining Plate
(9) Cap Screw
(10) Locking Washer
(11) Locking Nut

GOVERNOR DRIVE ASSEMBLY

FIG. 9



(1) Locking Nut
(2) Locking Washer
(3) Bearing Housing
(4) Bearing
(5) Bearing Retaining Plate
(6) Cap Screw
(7) Spacer
(8) Gear
(9) Bearing
(10) Shaft
(11) Key

STARTING FUEL PUMP DRIVE ASSEMBLY

FIG. 10

NOTE: PLACE LONG HUB OF GEAR TO THE REAR.

3. Install shaft, with gear assembled, into bearing (4) in rotor cage. Secure with locking washer (2) and locking nut (1).

(k) Install generator drive assembly. (Fig. 11)

1. Install rear bearing housing (5) into rotor cage, and install bearing (6).

2. Insert key (2) into shaft (1) and install gear (4). Place shaft into bearing (6) until it seats properly. Install locking washer (9) and locking nut (10).

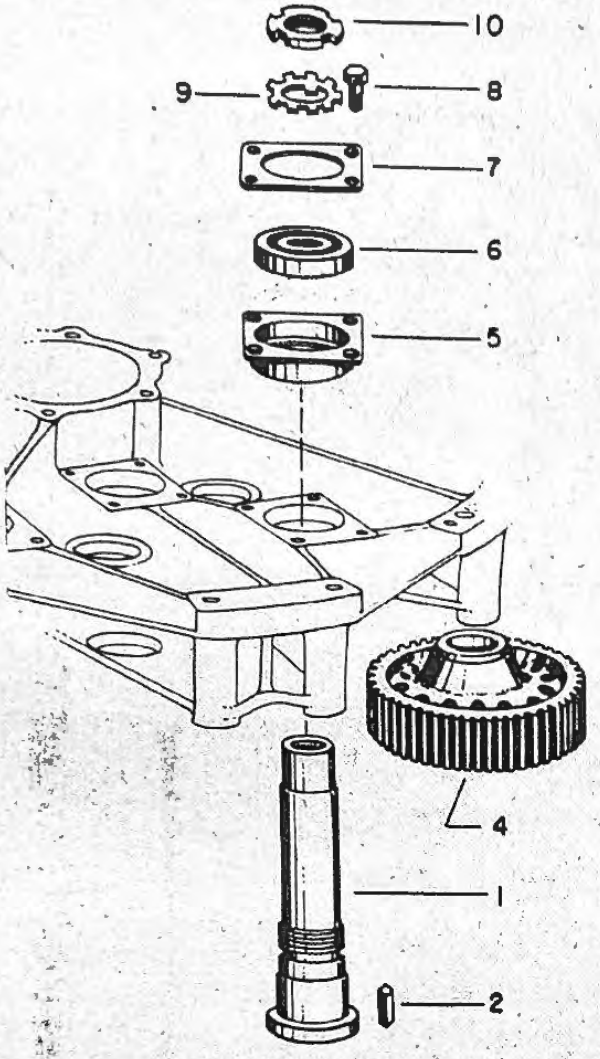
NOTE: PLACE LONG HUB OF GEAR TO FRONT.

3. Install bearing retaining plate (7) and secure with four (4) 1/4"-20x5/8" long cap screws (8).

(l) Install rotor cage, lifting ring and gear locking device No. 25125 to lock clutch pinion.

(m) Tighten all locking nuts and safety with locking washers.

(n) Install oil reservoir cover plate on bottom of rotor cage and secure with twenty-six (26) No. 6-32x3/8" flat head screws, lock by staking of metal into screw slots.



(1) Shaft
(2) Key
(3) Cotter Pin
(4) Gear
(5) Bearing Housing
(6) Bearing
(7) Bearing Retaining Plate
(8) Cap Screw
(9) Locking Washer
(10) Locking Nut

GENERATOR DRIVE ASSEMBLY

FIG. 11

(2) Place gear casing on overhaul stand No. 251,186 with flange side up.

(3) Install oil seals and bearings. (Fig. 12). (IF REMOVED)

NOTE: THE STARTER DRIVE SHAFT AND STARTING FUEL PUMP DRIVE SHAFT OIL SEALS ARE INSTALLED WITH THE LIPS FACING FRONT WHILE THE OTHER TWO FACE REAR SO THAT SUFFICIENT LUBRICATION IS PROVIDED TO KEEP THE SEALS FROM BURNING.

(a) Install starting pump bearing housing and oil seal (2). Secure with four (4) 1/4"-20x1/2" hex head cap screws and plain washers.

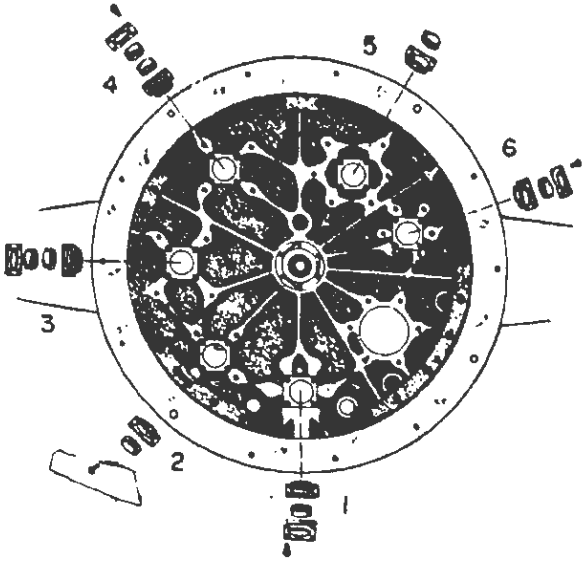
(b) Install oil seal and bearing into bearing housings for governor (3) and main fuel pump (4). Secure with four (4) 1/4"-20x5/8" hex head cap screws.

(c) Install bearing housing and bearing for lube pump (1). Attach bearing retaining plate with four (4) 1/4"-20x5/8" hex head cap screws and plain washers.

(d) Install bearing, seal and bearing housing for tachometer generator (6) and generator (5). Attach bearing retaining plate with four (4) 1/4"-20x5/8" hex head cap screws.

(e) Install oil seal and starter gear bearing housing. Secure with six (6) No. 10-24x5/8" fillister head screws.

(4) Install rotor cage. (Fig. 13)



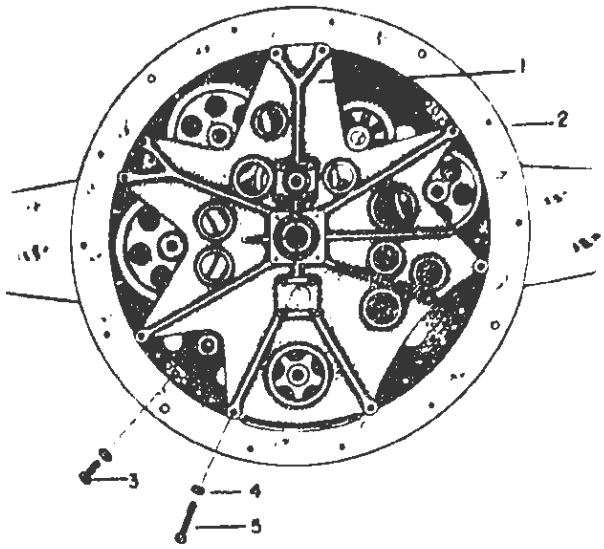
INSTALLATION OF OIL SEALS AND BEARINGS IN GEAR CASING

FIG. 12

(a) Install rotor cage assembly (1) in the gear casing and secure with nine (9) cap screws (3) and nine (9) 5/16" plain washers; also, seven (7) 5/16"-24x1 1/8" hex head cap screws (5) and 5/16" plain washers (4).

(b) Turn gears to see if all are free.

(5) Install ball support to lower mounting pad and place cover on upper mounting pad at final assembly.



(1) Rotor Cage
(2) Accessories Gear Casing
(3) Cap Screw
(4) Washer
(5) Cap Screw

INSTALL ROTOR CAGE

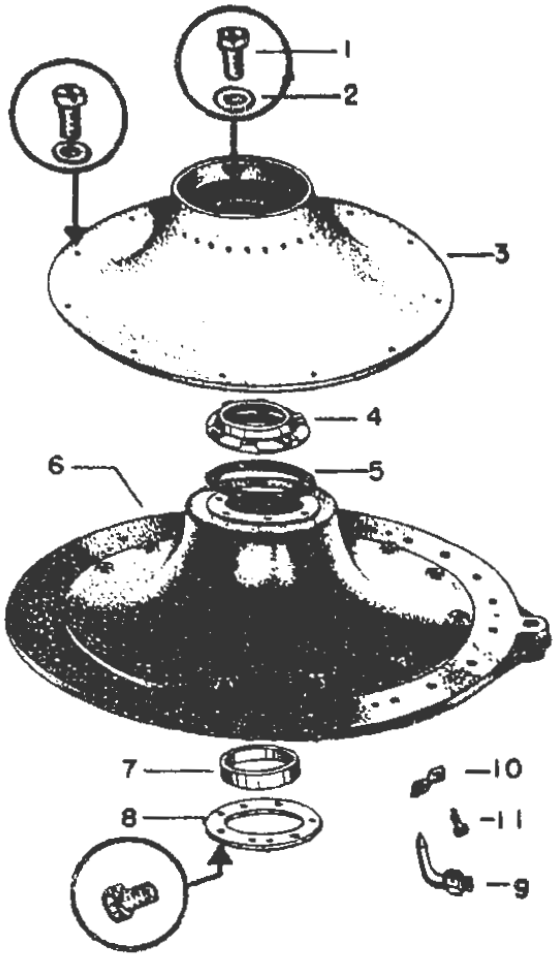
FIG. 13

b. COMPRESSOR UNIT ASSEMBLY

(1) Assemble rear compressor bearing support. (Fig. 14)

(a) Place compressor rear bearing support (6) on work bench, with rear surface up, and insert bearing housing.

(b) Install the outer race of roller bearing (7) into bearing housing. Attach the retaining ring (8), oil jet bracket (10). Secure with one No. 10-32x3/8" fillister head screw (11) and seven (7) 1/4"-28x3/4" cap screws (1).



(1) Cap Screw
(2) Washer
(3) Guide-Vane Assembly
(4) Oil Seal
(5) Gasket
(6) Rear Bearing Support
(7) Outer Race
(8) Retaining Ring
(9) Oil Jet Nozzle
(10) Oil Jet Bracket
(11) Fillister Head Screw

REAR BEARING SUPPORT ASSEMBLY

FIG. 14

NOTE: MAKE SURE THAT BRACKET IS IN POSITION TO RECEIVE OIL JET.

(c) Install oil jet (9).

(d) Turn unit over so rear surface is downward and install gasket (5), oil seal (4), and guide-vane assembly (3). Secure to support with six (6) No. 10-32x5/8" fillister head screws and washers at seal. Also fourteen (14) No. 10-32x3/8" screws at outer edge of support.

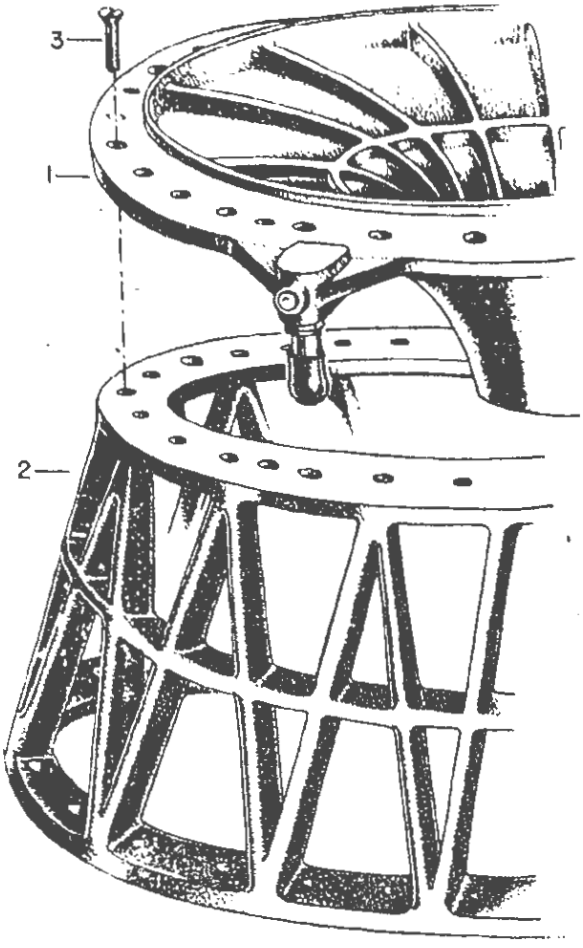
(2) Install rear truss ring to rear compressor bearing support assembly. (Fig. 15)

(a) Place rear truss ring, with large diameter downward, on work bench. Install rear bearing support on truss ring and secure with seven (7) 1/4"-28x7/8" flat head screws.

NOTE: ZEROS ON TRUSS RING AND BEARING SUPPORT MUST BE MATCHED. SCREWS MUST BE FLUSH OR BELOW SURFACE.

(3) Install guide blade assembly to compressor casing. (Fig. 16)

(a) Install rear guide blade assembly (4) to rear side of compressor casing, with fourteen (14) 1/4"-38x1/2" hex head cap screws (2) and plain washers (3).



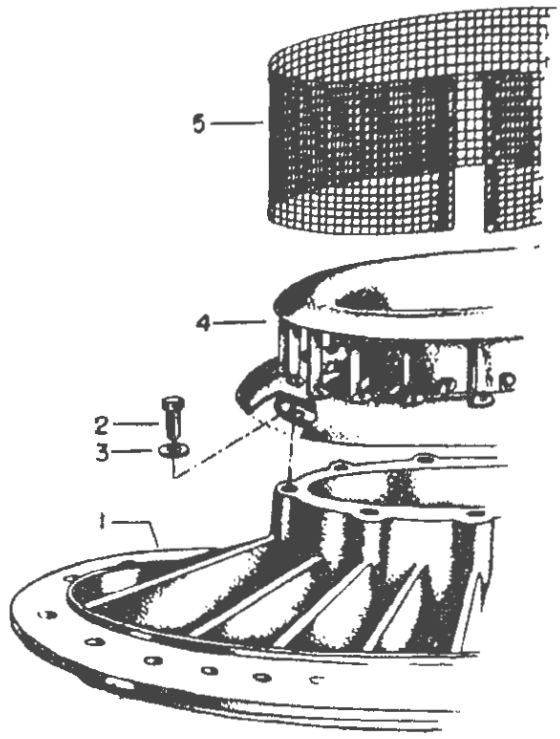
(1) Bearing Support Assembly
(2) Truss Ring
(3) Screw

REAR TRUSS RING TO BEARING SUPPORT

FIG. 15

(b) Place screen (5) over guide blades (4).

NOTE: DO NOT LACE TIGHTLY UNTIL AFTER PLACING COMPRESSOR CASING ON TRUSS RING.



(1) Rear Compressor Casing
(2) Cap Screw
(3) Washer
(4) Guide Blade Assembly
(5) Screen

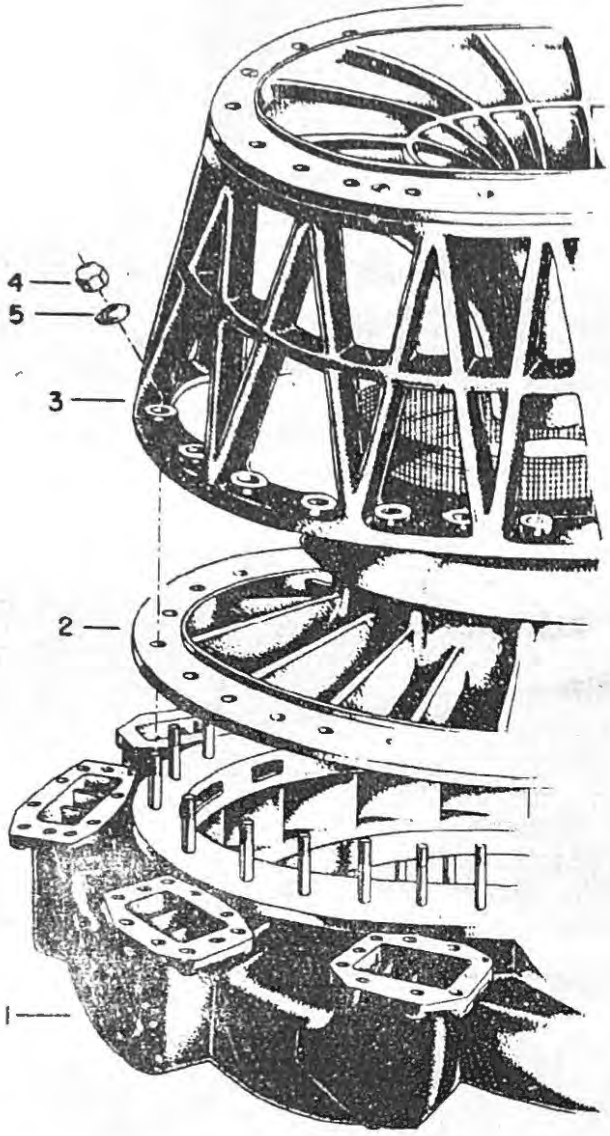
REAR COMPRESSOR ASSEMBLY

FIG. 16

(4) Install rear compressor assembly to diffuser assembly. (Fig. 17)

(a) Install diffuser (1) in place in stand #Z51,211.

(b) Install compressor casing and guide blades assembly (2) into position on diffuser.



(1) Diffuser
(2) Rear Compressor Casing Assembly
(3) Truss Ring and Bearing Support Assembly
(4) Nut
(5) Washer

INSTALL REAR COMPRESSOR ASSEMBLY

FIG. 17

(c) Install rear compressor bearing assembly and truss ring (3) on diffuser (1).

NOTE: LOCATE REAR BEARING SUPPORT AND TRUSS RING (3) SO THAT LIFTING BOSS ON DIFFUSER IS APPROXIMATELY EIGHT (8) DEGREES CLOCKWISE FROM THE OIL BOSS, ON REAR BEARING SUPPORT ASSEMBLY.

(d) Secure diffuser (1) assembly to compressor casing and truss ring (2) with nineteen (19) 3/8" conical washers (5) and nineteen (19) 3/8"-24 self-locking nuts (4). Tighten to specifications.

(5) Install trunnions, using the four front trunnion bolts and washers.

(6) Turn stand so that rear bearing support and truss ring (7) are down. (Fig 18)

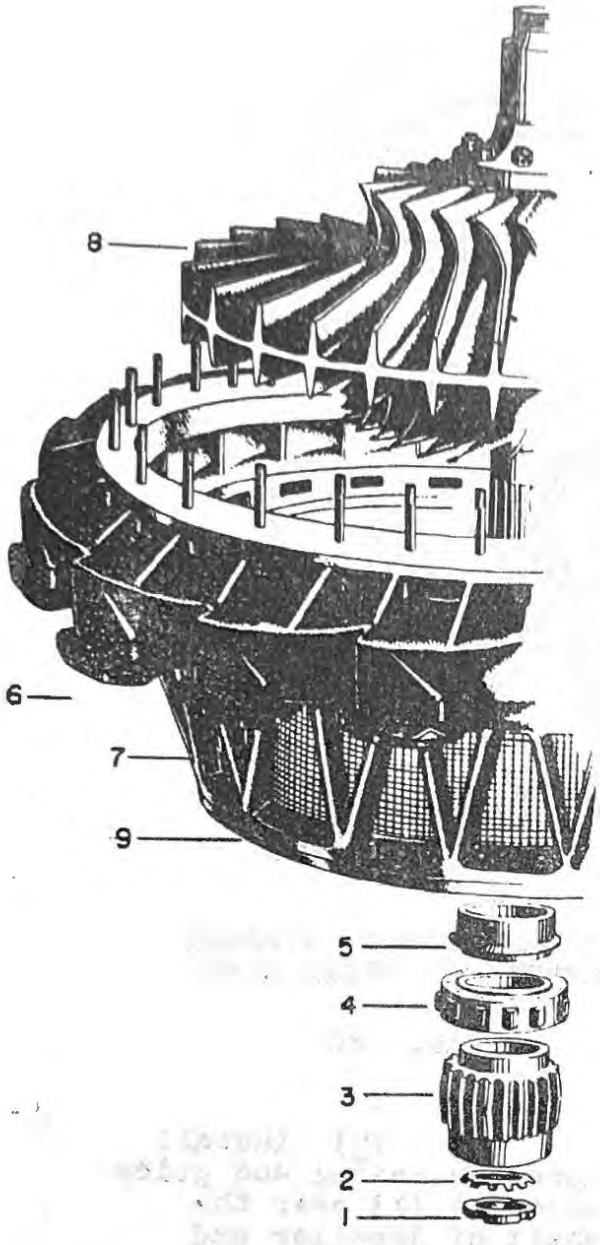
(7) Install the impeller (8) with front shaft and rear shaft attached, into the rear compressor bearing support (9). (Fig. 18)

CAUTION: WHEN LOWERING THE IMPELLER INTO THE UNIT, BE CAREFUL NOT TO DAMAGE THE REAR OIL SEAL.

NOTE: LEAVE IMPELLER SUPPORTED BY HOIST.

(8) Install rear bearing assembly. (Fig 18)

(a) Install oil deflector (5) on rear shaft, lining up its zero mark with the zero mark on stud holding the rear shaft to the impeller. Install roller bearing (4), lining up zero, then add hub (3) aligning its zero and lock in place with locking washer (2) and lock nut (1).



(1) Locking Nut
(2) Locking Washer
(3) Coupling Hub
(4) Roller Bearing
(5) Oil Deflector
(6) Diffuser
(7) Rear Truss Ring
(8) Impeller
(9) Rear Compressor Bearing Support

INSTALLATION OF IMPELLER

FIG. 18

(9) Assemble front bearing support assembly. (Fig. 19)

(a) Place front bearing support (4) on work bench with large diameter downward.

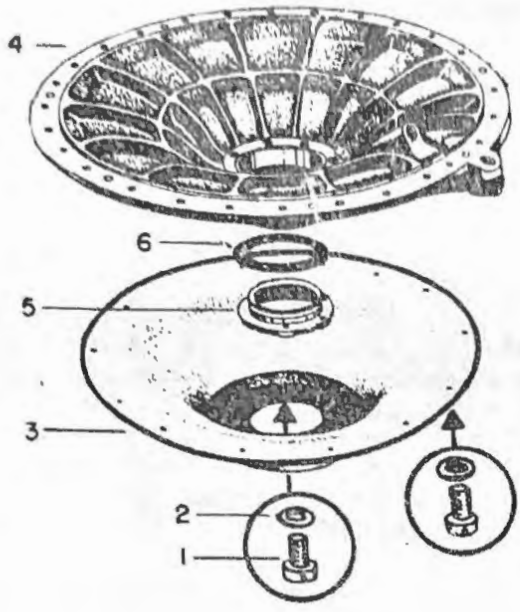
(b) Install oil seal gasket (6), oil seal (5) and guide vane assembly (3). Secure to support with six (6) No. 10-32 x 5/8" fillister head screws (1) and washers (2) at seal. Also fourteen (14) No. 10-32 x 3/8" screws at outer edge of support.

NOTE: RAM AIR PASSES FROM THE PLENUM CHAMBER OF THE AIRPLANE INTO THE AREA BETWEEN THE BEARING SUPPORT AND THE GUIDE VANE THEN THROUGH THE SEAL TO HELP PREVENT THE LOSS OF OIL. THIS MAKES IT NECESSARY THAT THESE PARTS ARE HANDLED AND INSTALLED WITH CARE.

(10) Install support assembly to truss ring. (Fig. 20)

(a) Install support so the oil boss is approximately 22 degrees clockwise from the lifting boss on the diffuser. Secure the support to truss ring with seven (7) 1/4"-28x7/8" flat head screws.

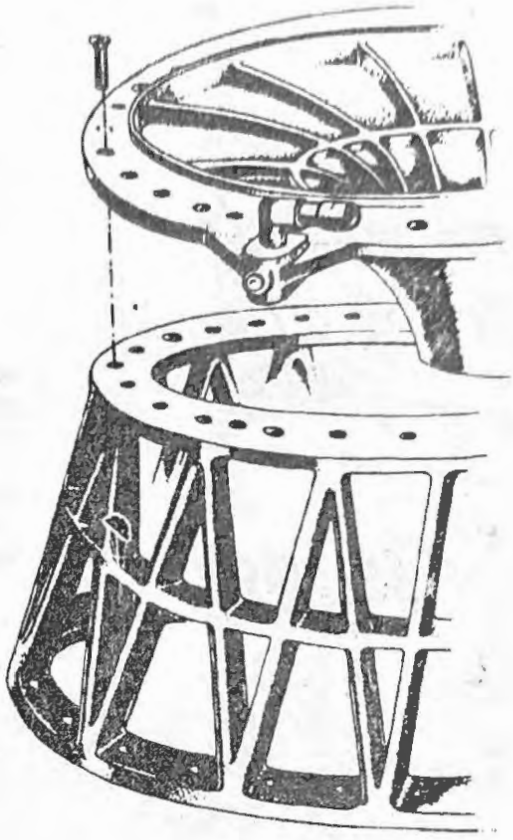
NOTE: ALIGN THE ZEROS ON TRUSS RING AND COMPRESSOR CASING. THE SCREW HEADS MUST BE FLUSH OR BELOW THE SURFACE.



(1) Fillister Head Screw
(2) Washer
(3) Guide Vane
(4) Front Bearing Support
(5) Oil Seal
(6) Gasket

ASSEMBLE FRONT BEARING SUPPORT ASSEMBLY

FIG. 19



INSTALL BEARING SUPPORT ASSEMBLY TO TRUSS RING

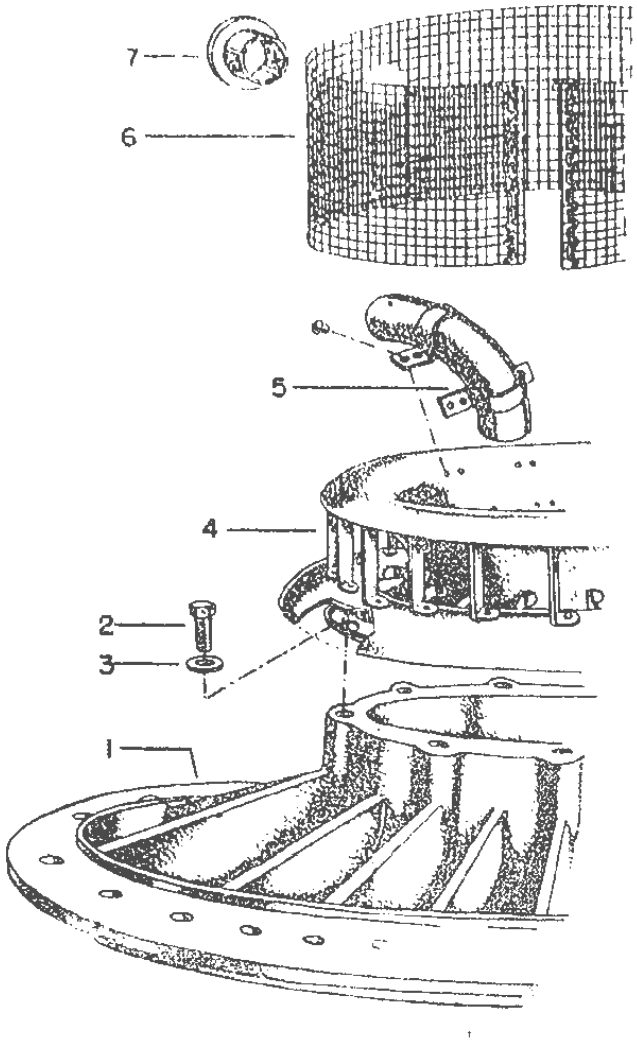
FIG. 20

(11) Assemble and install front compressor casing and guide blade assemblies. (Fig. 21)

(a) Install front guide blade assembly (4) to front half of compressor casing (1). Secure with fourteen (14) 1/4"-28x1/2" cap screws (2) and plain washers (3). Place screen (6) over guide blades, but do not lace tightly until after assembly on complete unit.

(b) Install the compressor casing and guide blade assembly (1) over the front shaft of impeller and onto diffuser (2). Locate by placing the generator air-cooling tube, approximately 39 degrees counter-clockwise from the lifting boss on the diffuser section. (Fig. 22)

(12) Install front truss ring and bearing support. (Fig. 22)



(1) Compressor Casing
(2) Cap Screw
(3) Washer
(4) Guide Blade Assembly
(5) Generator Cooling Tube
(6) Screen
(7) Grommet

ASSEMBLE FRONT COMPRESSOR CASING

FIG. 21

(a) Install front truss ring (4) and secure with 3/8" conical washers (5) and 3/8"-24 self-locking nuts.

NOTE: BEGINNING WITH #1 IN LINE WITH DIFFUSER MOUNTING BOSS AND WORKING COUNTER-CLOCKWISE FROM FRONT, DO NOT INSTALL NUTS ON FOLLOWING STUDS:- #1, #5, #9, #12, #13, #17, #21, #25, #26, #27. THESE ARE LEFT FOR FUTURE INSTALLATION OF FUEL MANIFOLD AND COIL ASSEMBLIES.

(13) Install front bearing assembly. (Fig. 22)

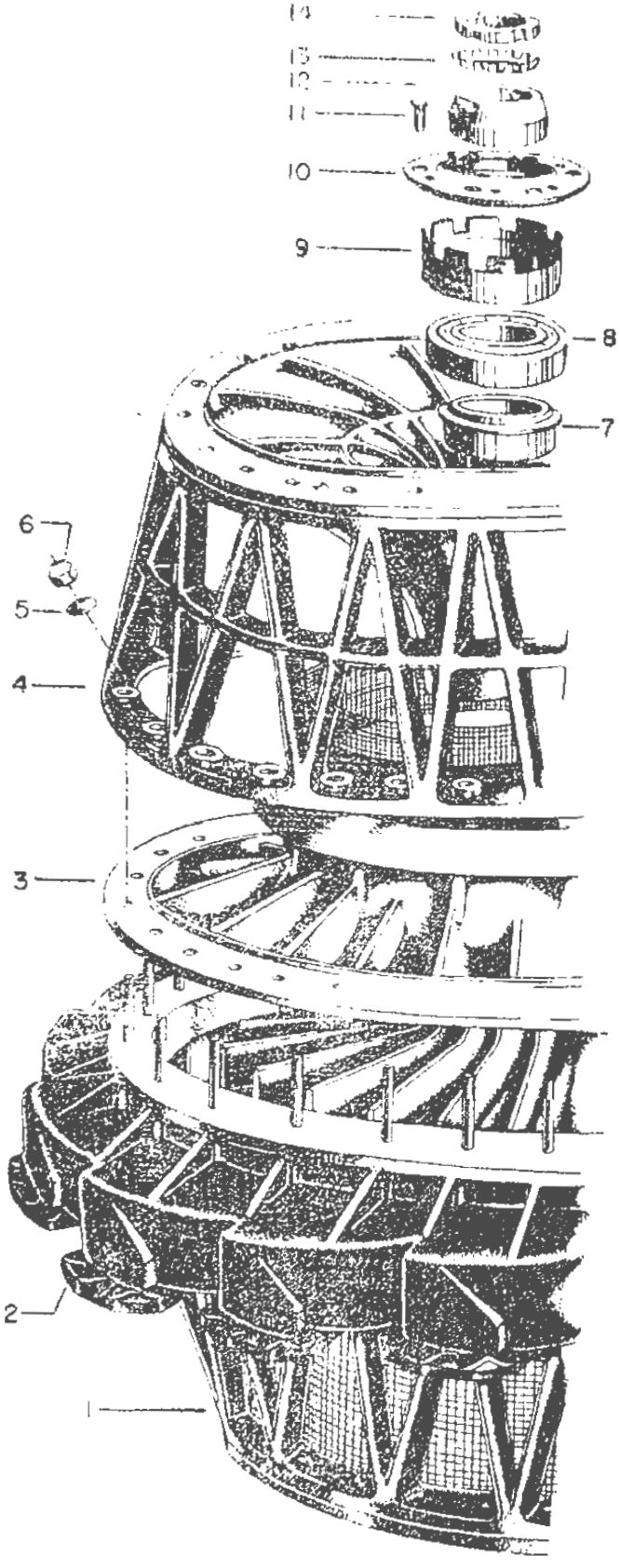
(a) Install oil deflector (7) over front shaft, aligning zeros on each. With bearing (8) installed in sliding ring case (9), install the assembly over shaft, and seat against oil deflector, aligning the zeros.

(b) Install spacer (12) onto shaft, and lock with washer and nut.

(c) Screw the adjusting nut (10) onto the sliding case, and continue to tighten until the impeller moves slightly away from the rear compressor case.

(14) Locate impeller. (Fig. 23)

(a) Install the impeller indicator bracket to the front bearing support. Attach to the bracket, an indicator with a range of 0.250", graduated to a reading of 0.001". Adjust the contact point to rest on the front shaft of the impeller. (Fig. 23)



(1) Compressor Casing Assembly
(2) Diffuser
(3) Rear Compressor Assembly
(4) Front Truss Ring and Bearing Support
(5) Washer
(6) Nut
(7) Oil Deflector
(8) Ball Bearing
(9) Sliding Ring Case
(10) Adjusting Nut
(11) Cap Screw
(12) Spacer
(13) Locking Washer
(14) Locking Nut

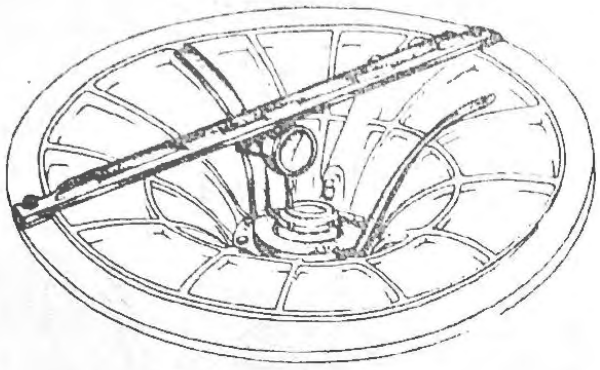
ASSEMBLY OF FRONT COMPRESSOR ASSEMBLIES TO DIFFUSER

FIG. 22

(b) Turn the impeller slowly and turn the sliding ring clockwise, to permit the impeller to rub lightly, the rear compressor casing.

(c) Set the indicator to zero. Turn sliding ring clockwise until the impeller has moved toward, and slightly rubs, the front compressor casing.

(d) Check the indicator and record the reading. This is the complete travel of the impeller. Divide the reading. Turn the sliding ring counter-clockwise to provide clearance, and using four cap screws, lower the impeller to a position equal to one-half the total indicator reading. (Check Specifications)



LOCATION OF IMPELLER

FIG. 23

(e) Remove the four cap screws. Tighten the adjusting nut to hold the impeller in position, and secure the adjusting nut to the front bearing support with seven (7) 1/4"-28x3/8" hex head cap screws (5) and lock plate (4). (Fig. 24)

CAUTION: DO NOT OMIT LOCK PLATE AS DAMAGE WILL RESULT TO UNIT, WHEN OPERATED WITHOUT IT.

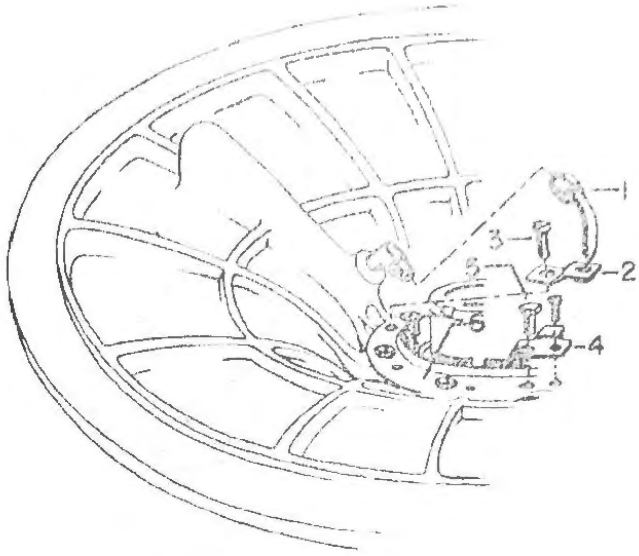
(f) Install the front bearing oil jet (1) and bracket (2). Secure with one No. 10-32x1/4" fillister head screw (3).

(g) Check to see impeller turns freely.

c. TURBINE UNIT ASSEMBLY

The Turbine Unit Assembly is made up of three minor sub-assemblies:

The Turbine Bearing Support Assembly.
The Ring and Tube Assembly.
The Turbine Rotor Assembly.



(1) Oil Jet
(2) Oil Jet Bracket
(3) Fillister Screw
(4) Lock Plate
(5) Cap Screw
(6) Adjusting Nut

INSTALLATION OF OIL JET AND BEARING LOCKING PLATE

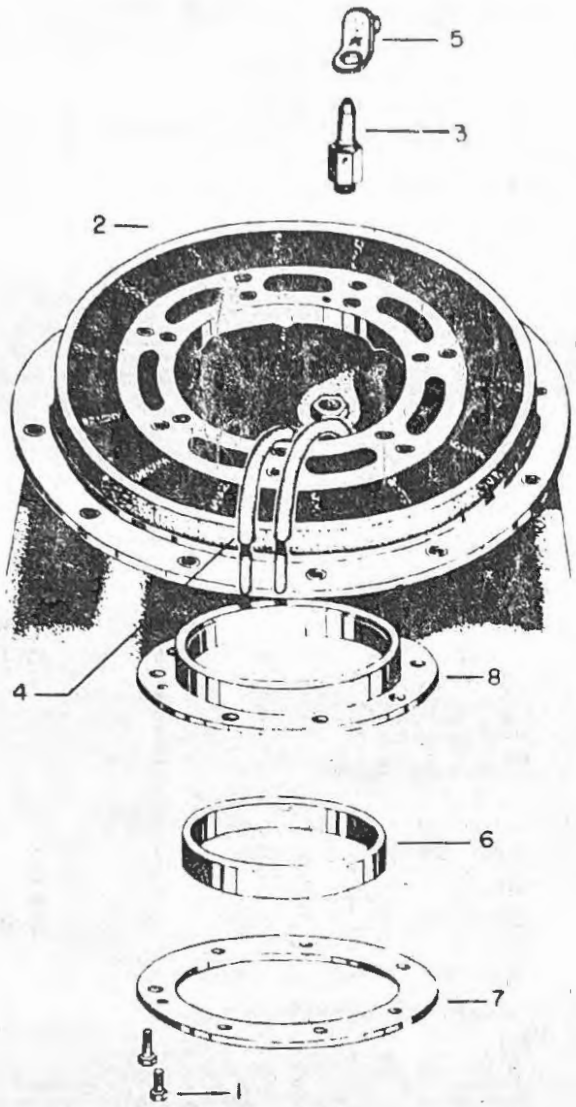
FIG. 24

(1) Build Turbine Bearing Support Assembly. (Fig. 25)

(a) Place the bearing support (2) on table and install oil jet (3).

(b) Install thermocouple leads (4) into rear bearing housing (8).

(c) Install rear bearing outer race (6) in turbine bearing housing (8) and install both in bearing support. Attach retainer ring (7) and secure with seven (7) 1/4"-28x3/4" hex head cap screws (1).



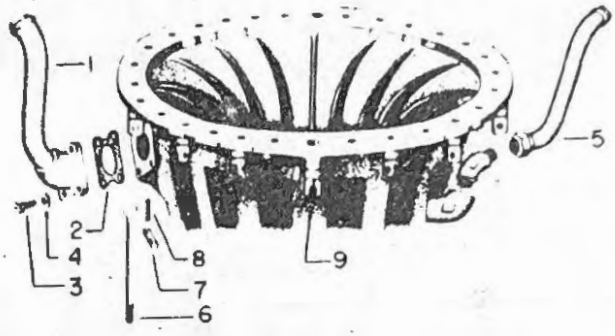
(1) Cap Screw
(2) Bearing Support
(3) Oil Jet
(4) Thermocouple Leads
(5) Jet Bracket
(6) Bearing Outer Race
(7) Retainer Ring
(8) Bearing Housing

ASSEMBLY OF REAR BEARING HOUSING TO BEARING SUPPORT

FIG. 25

(d) Install one (1) 1/4"-28x1 5/8" hex head cap screw (1) and rear jet bracket (5).

(e) Install gasket (2) and scavenge tube assembly (1). Socure with four (4) 1/4"-28x3/4" hex head cap screws (3) and plain washers (4). (Fig. 26)



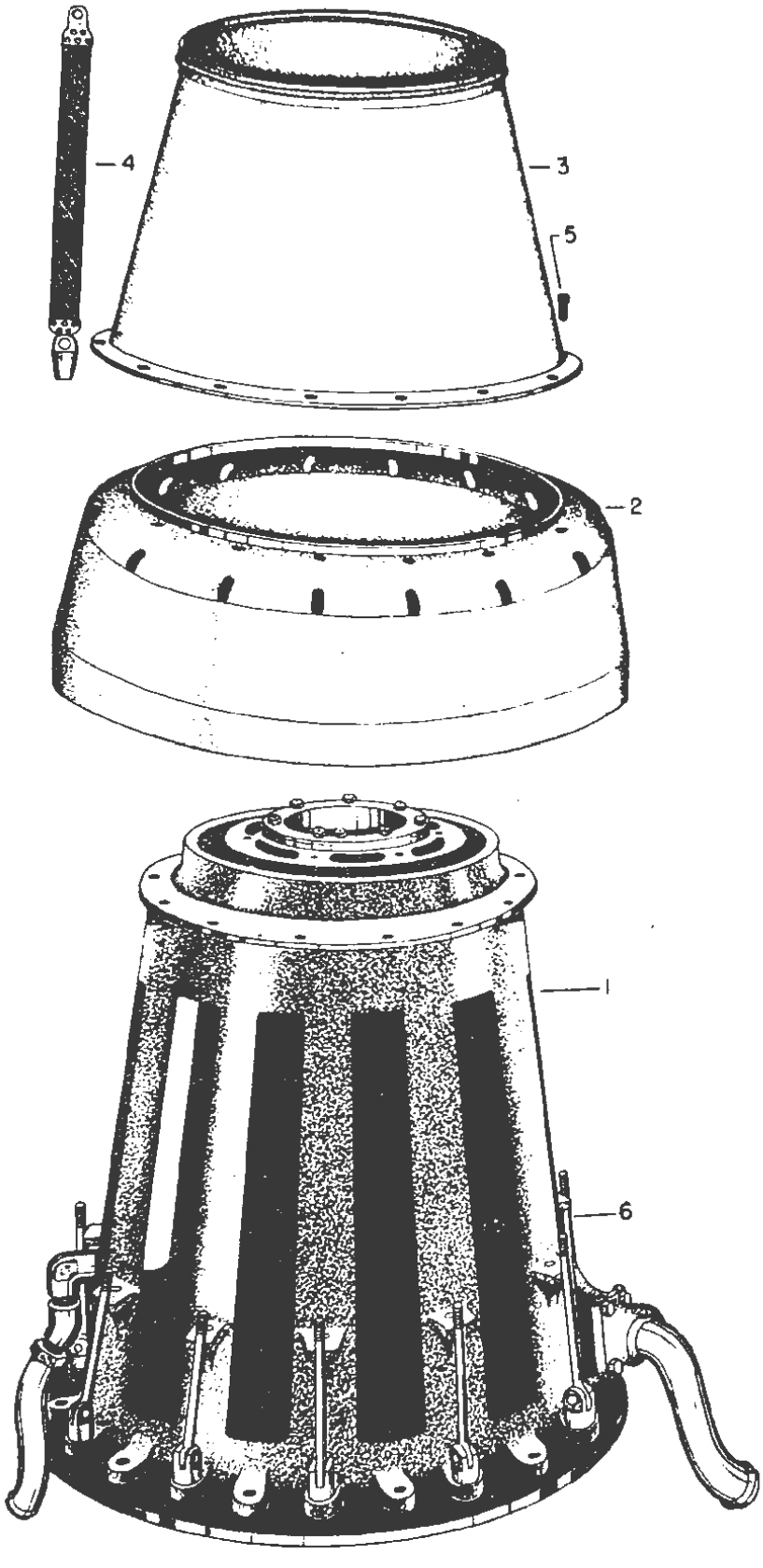
(1) Scavenge Tube
(2) Gasket
(3) Cap Screws
(4) Plain Washer
(5) Rear Bearing Oil Tube
(6) Tie Rod
(7) Clevis Pin
(8) Cotter Pin
(9) Clevis Bushing

INSTALL OIL TUBE ASSEMBLIES

FIG. 26

(f) Install rear bearing oil tube assembly (5) in the tapped hole, opposite the scavenge tube. Attach all lines temporarily to determine the proper position of elbows.

(g) Install each of the fourteen tie rods (6) to a clevis bushing (9) and secure with clevis pin and cotter pins.



(1) Bearing Support Assembly.
(2) Front Shroud
(3) Rear Shroud
(4) Tie Strap and Clevis Assembly.
(5) Fillister Screw
(6) Tie Rods

INSTALL SHROUDS

FIG. 27

NOTE: SCREW EACH CLEVIS ON TO TIE ROD UNTIL THE FLAT SIDE OF THE STRAP IS IN A PERPENDICULAR PLANE WITH THE CENTER LINE OF THE SUPPORT, AND LEAVE APPROXIMATELY 2 THREADS SHOWING ON THE TIE RODS.

(h) Tighten the rear bearing oil tube, aligning it in proper position for assembly to the oil pipe.

(i) With bearing support resting on the large end, install the front shroud (2), guiding the tie rods (6) through the holes in shroud. (Fig. 27)

(j) Install the rear shroud (3) over support and align the screw holes with those in the front shroud. Temporarily, secure with four (4) No. 10-32x3/8" fillister head screws. (Fig. 27)

(k) Assemble the fourteen (14) tie-strap and clevis assemblies (4) to the tie rods (6). (Fig. 27)

(l) Install the remaining No. 10-32x1/2" fillister head screws to secure the shrouds to the support.

(2) Build Ring and Tube Assembly. (Fig. 28)

(a) Place the ring and tube assembly on table with small diameter downward.

(b) Install the even-numbered inner liners (5) into the correspondingly numbered outer chambers. Secure with lock washer (7) and special dowel screw (3).

(c) Working through the odd-numbered outer chambers, install the cross-over tubes (6), pushing them down into the even-numbered flame tubes.

(d) Install the odd-numbered inner liners (5) into position and lock in place with lock washer (7) and screw (3). Push the cross-over tubes into position and secure to clip in odd-numbered flame tubes, with Nichrome lock wire.

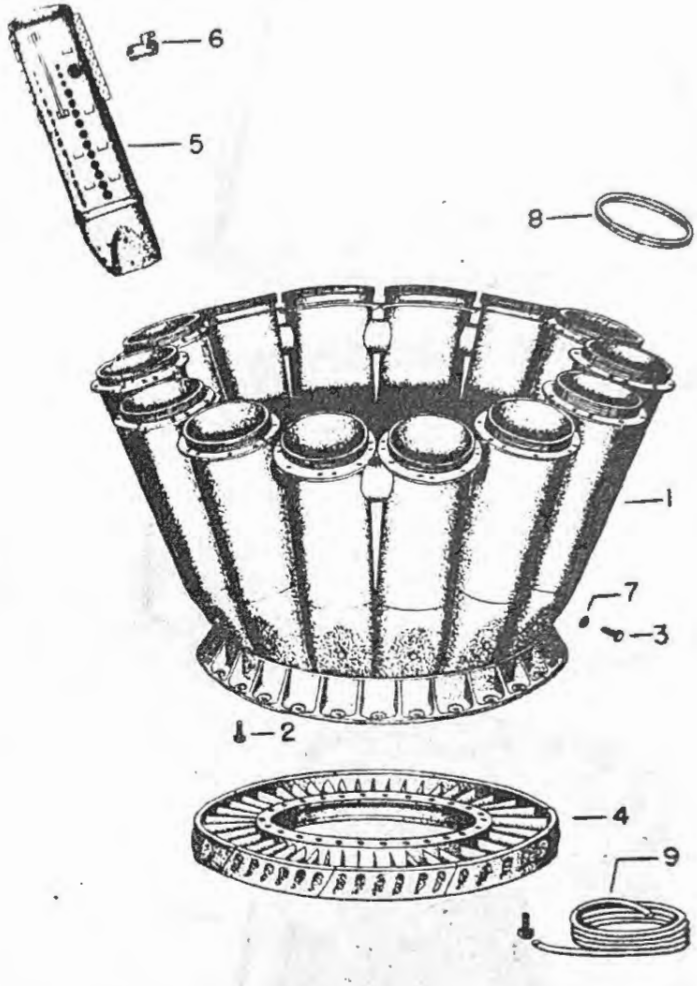
(e) Install the piston rings (8) into grooves on the front of the outer chambers.

(f) Turn the ring and tube assembly over with the large diameter downward.

(g) Install the diaphragm assembly (4) into the recess in the ring and tube assembly. Secure with twenty-eight (28) special 5/16"-24x5/8" long cap screws (2), using antisize compound.

(h) Pack the space around the diaphragm with asbestos packing (9).

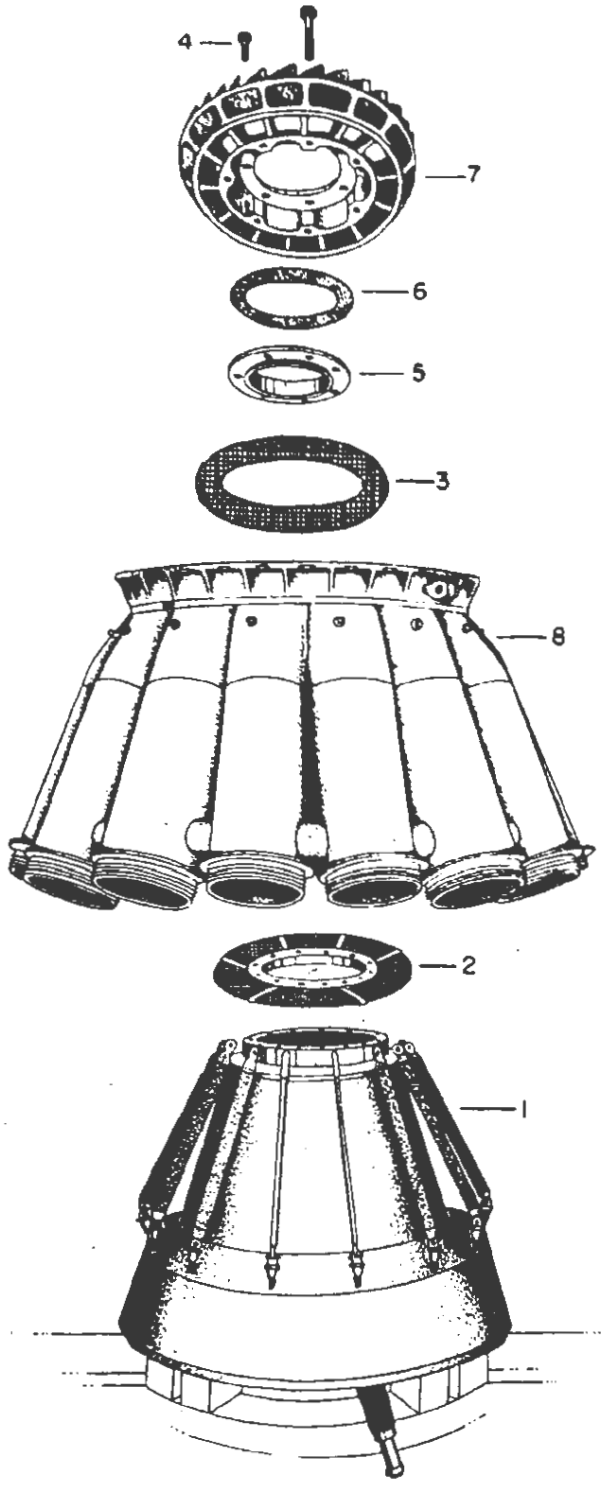
NOTE: FILL TO ABOUT 1/32" FROM THE OUTER EDGE OF DIAPHRAGM. (USE TAMPING TOOL #AD80097)



(1) Ring and Tube Assembly
(2) Cap Screw
(3) Dowel Screw
(4) Nozzle Diaphragm
(5) Inner Liner
(6) Crossover Tube
(7) Lock Washer
(8) Piston Ring
(9) Asbestos Packing

ASSEMBLE RING AND TUBE ASSEMBLY

FIG. 28



(1) Turbine Bearing Support Assembly.
(2) Air Baffle and Screen Assembly.
(3) Turbine Diffuser Screen
(4) Cap Screw
(5) Oil Seal
(6) Oil Seal Gasket
(7) Diffuser
(8) Ring and Tube Assembly

INSTALLATION OF RING AND TUBE ASSEMBLY

FIG. 29

(3) Installation of Ring and Tube Assembly to Turbine Bearing Support Assembly. (Fig. 29)

(a) Install air baffle (2) into position on bearing support. Lower ring and tube assembly (8) over bearing support (1). Locate by having oil inlet between combustion chamber 1 and 2. Secure ring and tube assembly and air baffle to bearing support with fourteen (14) cap screws 5/16"-24x5/8" long.

(b) Install oil seal (5) with gasket (6) to turbine diffuser (7). Secure with six (6) No. 10-32x7/16" long fillister head screws and light washer.

(c) Install diffuser assembly (7) to bearing support, using gasket and screen (3). Secure with seven (7) 1/4-28x3/4" hex head cap screws and plain washers.

(4) Installation of Turbine Rotor Assembly. (Fig. 30)

(a) With turbine wheel (1) on stand No. Z51,252, install oil deflector (2) over shaft. Install roller bearing (3) and spacer (4). Secure to shaft with locking washer (5) and locking nut (6).

NOTE: MATCH ZEROS ON ALL MARKED PARTS. INSTALL SHAFT GUIDE IN FRONT BEARING OF HOUSING BEFORE LOWERING OVER TURBINE SHAFT.

(b) With lifting sling No. Z51,257 attached to lifting plate on ring and tube assembly (2), raise assembly and lower it over turbine rotor assembly (1).. (Fig. 31)

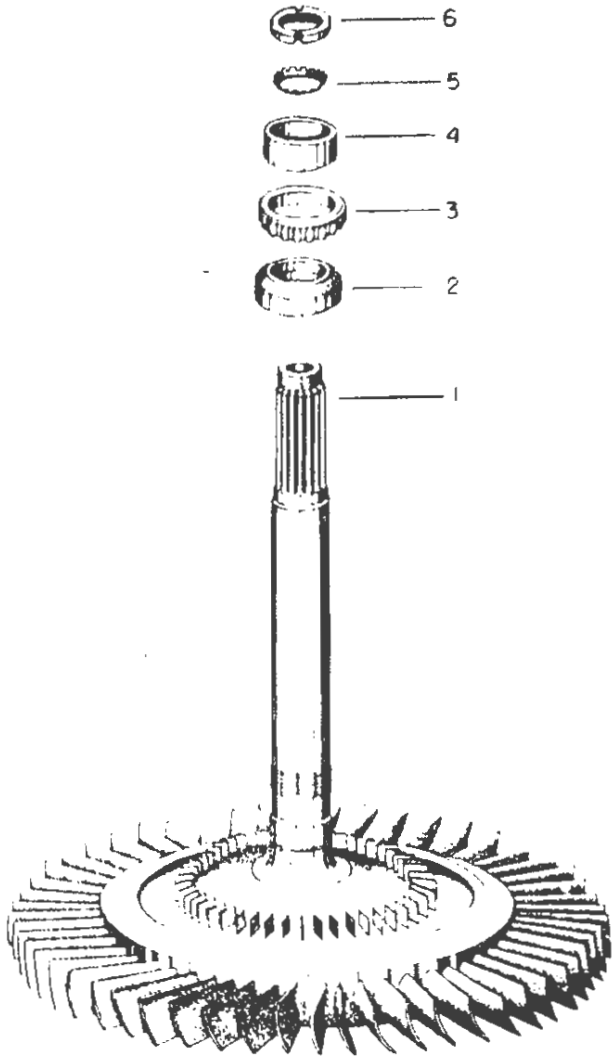
CAUTION: DO NOT DAMAGE THE OIL SEAL.

NOTE: IT WILL BE NECESSARY FOR THE REAR BEARING OIL JET TO PASS THE LOCKING NUT ON TURBINE SHAFT AT POINT WHERE TAB WASHER IS LOCKHED INTO LOCKING NUT.

(c) With ring and tube assembly resting on outer edge of stand and turbine on jack-plate, raise turbine assembly with jack until turbine wheel is touching gas baffle.

(d) Install ball bearing (4) in sliding ring (3). Install retaining nut (5). Install this assembly over turbine shaft and into bearing support lining up the zeros.

(e) Place coupling ring (7) and turbine coupling hub (8) over shaft. Hold in place with locking washer (9) and locking nut (10).



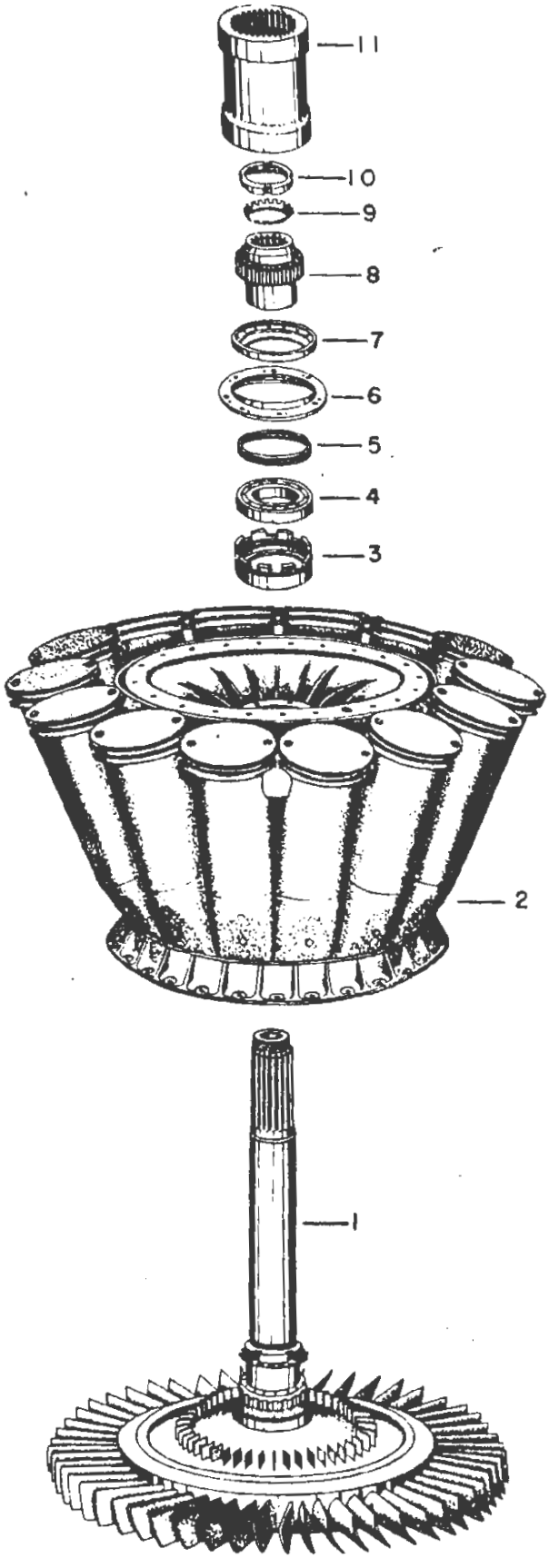
(1) Turbine Wheel
(2) Oil Deflector
(3) Roller Bearing
(4) Spacer
(5) Locking Washer
(6) Locking Nut

ASSEMBLY OF REAR BEARING TO TURBINE WHEEL ASSEMBLY

FIG. 30

NOTE: DO NOT BEND TAB ON WASHER AT THIS TIME.

(f) Install adjusting nut (6) over sliding ring (3).



(1) Turbine Wheel Assembly
(2) Ring and Tube Assembly
(3) Sliding Ring
(4) Ball Bearing
(5) Retaining Nut
(6) Adjusting Nut
(7) Coupling Ring
(8) Coupling Hub
(9) Locking Washer
(10) Locking Nut
(11) Coupling Sleeve

INSTALLATION OF RING AND TUBE ASSEMBLY TO TURBINE WHEEL ASSEMBLY

FIG. 31

(g) Install coupling sleeve to coupling ring and secure with sixteen (16) socket head cap screws.

(h) Set the turbine wheel clearance by the following procedure. (Fig. 32)

1. Install bracket on bearing support and attach indicator with point of indicator resting on front of turbine shaft.

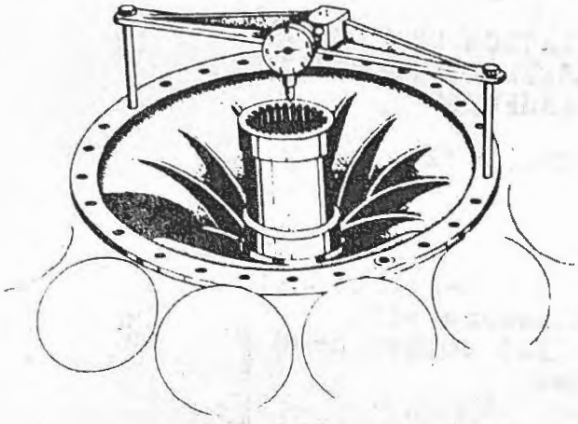
2. With jack under assembly stand, jack up turbine wheel, slowly rotate wheel while using jack until a slight rubbing is heard on gas baffle.

3. Screw down the adjusting nut until it seats lightly on bearing support and set indicator to read zero.

NOTE: INDICATOR SHOULD BE COMPRESSED TO ASSURE APPROXIMATELY .080 TRAVEL.

4. Lower jack to free turbine wheel.

5. Back off adjusting nut until indicator reads 0.060 to 0.070" and line up holes for cap screws. (Refer to Table of Limits for latest clearance)



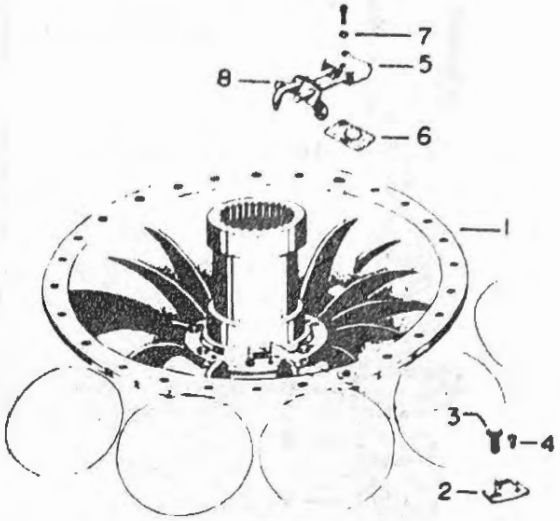
SETTING TURBINE TO GAS BAFFLE CLEARANCE

FIG. 32

(i) Install front turbine oil jet assembly (5). Secure with three light washers (7) and three No. 10-32x1 1/4" fillister head screws (4).

(j) Install the oil jet bracket (8). Secure bracket and lock plate (2) with seven 1/4-28x5/16" cap screws. Also install fillister head screws (4) in lock plate.

NOTE: PLACE LOCK PLATE UNDER THE PROPER CAP SCREWS SO THAT PRONG FITS NOTCH OF ADJUSTING NUT.



(1) Bearing Support Assembly
(2) Lock Plate
(3) Cap Screw
(4) Fillister Head Screw
(5) Oil Jet Assembly
(6) Oil Jet Gasket
(7) Washer
(8) Oil Jet Bracket

INSTALLATION OF FRONT OIL JET AND LOCK PLATE

FIG. 33

2. FINAL ASSEMBLY OF ENGINE

NOTE: CHECK SECTION V FOR TIGHTENING PROCEDURES

a. INSTALLATION OF ACCESSORIES DRIVE UNIT. (FIG. 34)

(1) Turn compressor unit (1) so that diffuser is horizontal.

(2) Install gasket (2) on the bearing support mounting surface.

(3) Turn accessories gear stand until the front of assembly is at the top, and attach sling No. Z51,205 (4) to the front of drive unit (3).

(4) Install accessories drive shaft (9) in compressor front shaft.

NOTE: THE TWO ENDS OF THE SHAFT ARE IDENTICAL. BE SURE SPLINES ARE PROPERLY ENGAGED.

(5) Lower accessories unit into position on front bearing support.

(a) Guide drive shaft into splines of clutch shaft as unit is lowered.

NOTE: IT MAY BE NECESSARY TO TURN IMPELLER TO ENGAGE SPLINES.

(6) Insert thirteen (13) 5/16"-24x11/16" long bolts (7) fitted with thick 3/8" washers (6), through holes at the V's of the truss ring and through the accessories casing flange. Secure the bolts at the front with 3/8" conical washers and self-locking nuts (8).

(7) Insert two (2) 5/16"-24x2 3/4" long bolts at each side of lifting attachment, and twelve (12) 5/16"-24x2 9/16" long bolts in the remaining holes using the same washer-nut combination as in step (5).

(8) Install a 3/8"-24x4 7/64" long cap screw with a 3/8" thick washer in the attaching hole at the bottom of the casing.

(9) Snug attaching bolts and cap screws.

(a) After the first bolt is snug, advance 180° to the next, then back 90° for the next, then advance 180°. The remaining may be tightened in any sequence.

(10) Torque accessories casing to bearing support nuts and cap screws according to limits given in section V of this manual.

(11) Install front support to accessories casing, IF REMOVED.

(a) Build front ball support.

1. Place male support through hole in support cap so ball fits into cap.

2. Screw female support over male support threads.

(b) Install support assembly.

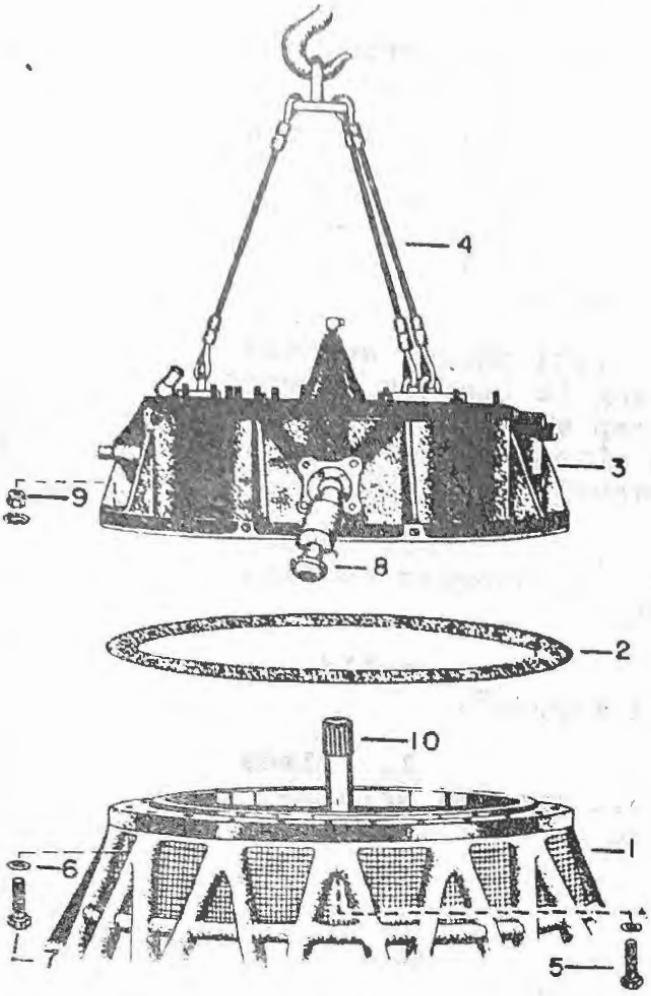
1. Fit ball seat to ball and cap.

2. Attach to accessories casing with four (4) 5/16"-24x1 1/8" long cap screws.

b. INSTALLATION OF TURBINE UNIT ASSEMBLY.

(1) Turn stand to horizontal position.

(a) Attach one end of sling No. Z51,168 to diffuser flange and other to accessories gear casing.



(1) Compressor Unit
(2) Gasket
(3) Accessories Drive Unit
(4) Sling
(5) Cap Screw
(6) Washer
(7) Bolt
(8) Ball Support
(9) Nut
(10) Accessories Drive Shaft

INSTALLATION OF ACCESSORIES DRIVE UNIT

FIG. 34

(b) With hoist, remove the assembly from engine stand No. Z51,176 and place in stand No. Z51,168. Fasten engine securely by trunnions and ball support.

(2) Turn stand until accessories unit is at bottom.

(3) Lift turbine unit with sling (7). (Fig. 35)

(4) Install gasket (4) on compressor bearing support (1).

(5) Lower turbine unit (6) over compressor assembly.

(a) Align zero mark on compressor rotor hub with zero mark on sleeve.

(b) Align lifting boss on diffuser with lifting boss (8) on ring and tube assembly.

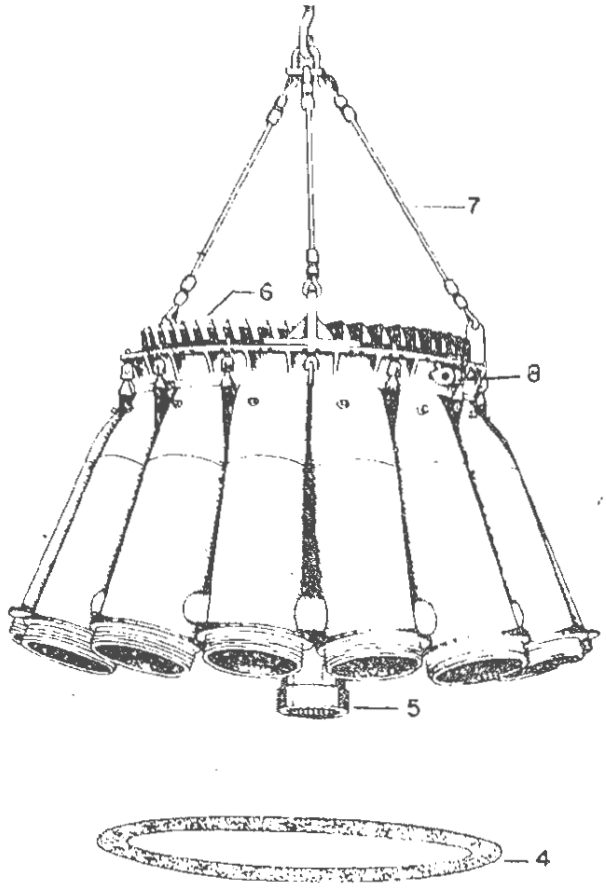
(6) Install fourteen (14) 3/8"-24x2 5/8" long cap screws (2) in the attaching holes at the inside of the V's of the truss ring. Use special washers (3) under the cap screw heads.

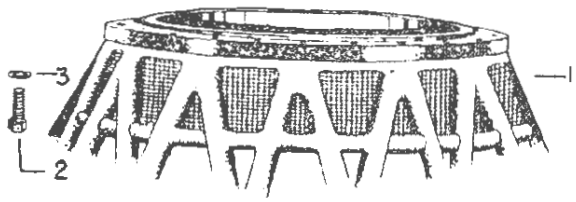
NOTE: KEEP A SLIGHT TENSION ON CHAIN HOIST DURING INSTALLATION.

(7) Install the fourteen (14) air baffles between the combustion chambers, (6). (Fig. 36)

(a) Install the twelve double and two single baffle brackets (5) to truss ring with fourteen (14) 3/8"-24x1 5/8" long cap screws (4) and special washers (7).

NOTE: SINGLE BRACKETS ARE USED IN THREE LOCATIONS WHERE THERE IS INTERFERENCE AT THE OIL SCAVENGE LINE AND AT THE OIL-IN FITTING AND OIL-IN LINE.





(1) Rear Compressor Bearing Support.
(2) Cap Screw
(3) Washer
(4) Gasket
(5) Coupling Sleeve
(6) Turbine Unit
(7) Sling
(8) Lifting Boss

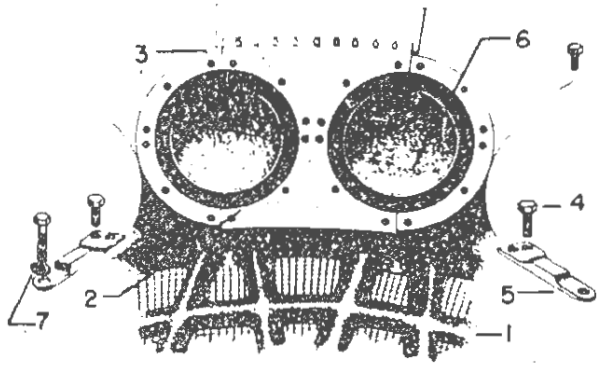
INSTALLATION OF TURBINE UNIT ASSEMBLY

FIG. 35

(b) Install fourteen (14) inner air baffles (2) to tube assembly. Secure to flange with six (6) No. 10-32x19/32" long cap screws (4).

(c) Install outer air baffles (3) to tube assembly. Secure to flange with six (6) No. 10-32x1 19/32" long cap screws (4).

NOTE: BAFFLES NOS. 1 AND 14 ARE NOTCHED FOR OUTSIDE LINES.



(1) Truss Ring
(2) Inner Air Baffle Sector
(3) Outer Air Baffle Sector
(4) Cap Screw
(5) Bracket
(6) Combustion Chamber
(7) Special Washer

INSTALLATION OF AIR BAFFLES

FIG. 36

(8) Install air adapters to engine. (Fig. 37)

(a) Build air adapter assemblies.

1. Install nozzle (6) into adapter (8).

a. Install gasket (7) on nozzle.

b. Install nozzle into adapter.

c. Tighten to specifications.

2. Install fuel filter (9).

a. Install filter into housing.

b. Place spring (10) on top of filter.

c. Install gasket (12) to plug (11) and screw plug into adapter.

d. Install dome (5) and secure with three (3) No. 10-24x5/8" long cap screws (4).

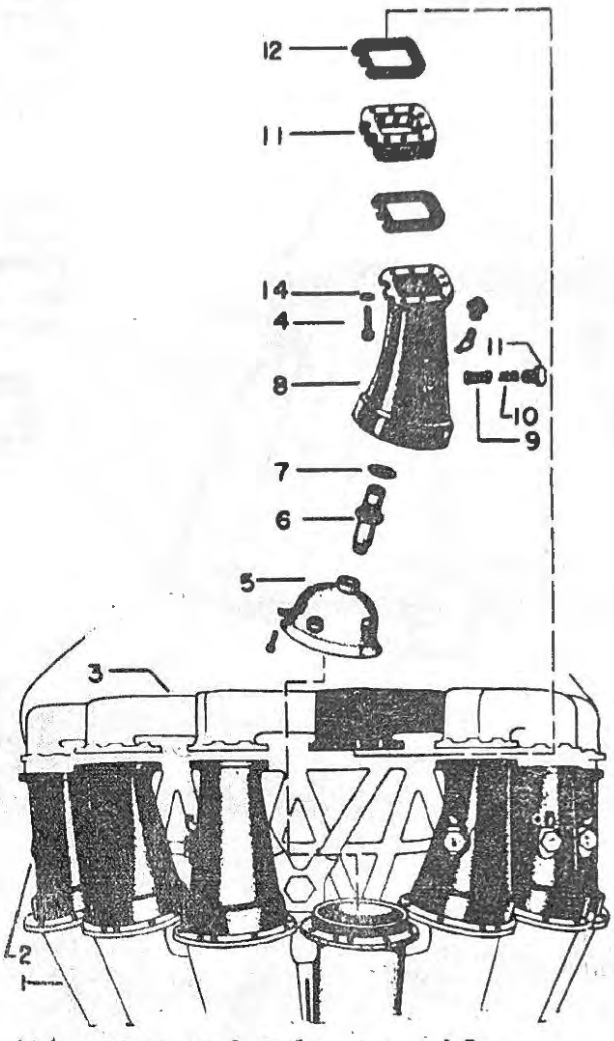
(b) Install adapters to engine.

1. Push adapters over rings of combustion assembly.

2. Place a gasket (12) on both sides of a spacer and insert between diffuser (3) and air adapter (2).

NOTE: PLACE THIN FLANGE OF SPACER TO THE FRONT.

3. Secure adapters and spacers to diffuser with ten (10) 1/4" plain washers (14) and ten (10) 1/4"-28x1 25x32" long cap screws (4).



(1) Ring and Tube Assembly
(2) Air Adapter Assembly
(3) Diffuser
(4) Cap Screw
(5) Dome
(6) Fuel Nozzle
(7) Gasket
(8) Adapter
(9) Filter
(10) Filter Spring
(11) Filter Plug
(12) Gasket
(13) Spacer
(14) Washer

INSTALLATION OF AIR ADAPTER ASSEMBLIES

FIG. 37

c. INSTALL ACCESSORIES TO ENGINE. (FIG. 38)

(1) Install lube pump (1).

(a) Match splines on pump drive adapter with those on the drive shaft at the six o'clock position on the accessories drive unit, and install gasket (2).

(b) Install pump with the two outlet ports at the top.

(c) Secure with six (6) 5/16" plain washers and six (6) 5/16"-24x1" long cap screws.

(2) Install governor (3).

(a) Match splines on drive shaft to those on the shaft at the three o'clock position of the accessories drive unit, and install gasket (4).

(b) Install governor to engine. Line up match marks on flanges of accessories casing and on the governor.

(c) Secure with four (4) 5/16" washers and four (4) 5/16"-24 self-locking nuts.

(3) Install fuel pump (5).

(a) Match splines of pump drive to those of accessories drive shaft in the one o'clock position, and install pump gasket (6).

(b) Install pump to engine with mark on flange matching that on the casing.

(c) Secure with four (4) 5/16" plain washers and four (4) 5/16"-24 self-locking nuts.

(4) Install generator (7).

(a) Match splines on drive shafts and install gasket (8) in eleven o'clock position on casing.

(b) Install generator to engine with mark on flange matching that on casing.

(c) Secure to engine with six (6) 3/8" plain washers and six (6) self-locking nuts.

(5) Install starting fuel pump cover pad (9).

(a) Install gasket (10) and pad to casing at the five o'clock position.

(b) Secure with four (4) 5/16" plain washers, and four (4) 5/16"-24 self-locking nuts.

(6) Install tachometer generator (11).

(a) Install tachometer generator adapter (12).

1. Place gasket and adapter on the six (6) studs at the nine o'clock position.

2. Secure with six (6) plain washers and six (6) 5/8"-24 self-locking nuts.

(b) Install tachometer generator.

1. Match splines and install gasket (13).

2. Match marks on flanges and install tachometer generator on the adapter.

3. Secure with four (4) 1/4" plain washers and four (4) 1/4"-28x5/8" long cap screws.

(7) Install starter assembly (14).

(a) Match marks on flanges and install gasket (15).

(b) Install starter on six (6) studs in the seven o'clock position.

(c) Secure with six (6) 3/8" plain washers and six (6) 3/8"-24 self-locking nuts.

NOTE: IT MAY BE NECESSARY TO TURN KNOB ON STARTER TO ENGAGE THE STARTER GEARS.

(8) Install barometric (16).

(a) Place barometric and bracket assembly on four (4) studs on front of lube pump.

(b) Secure with four (4) 1/4"-28 self-locking nuts.

(9) Install lube filter (17).

(10) Install control valve. (Fig. 39)

(a) Place control valve on left side of accessories casing.

(b) Secure with three (3) 1/4" plain washers and three (3) 1/4"-28x5/8" long cap screws.

(11) Install ignition coil and fuel manifold.

(a) Install coil and bracket assemblies to the two diffuser studs in line with combustion chamber no. 7, and on those in line with No. 14. (Fig. 40)

1. Secure each with two (2) 3/8"-24 self-locking nuts.

2. Install clamp to guide vane flange with one (1) 1/4"-20x1 1/32" long cap screw.

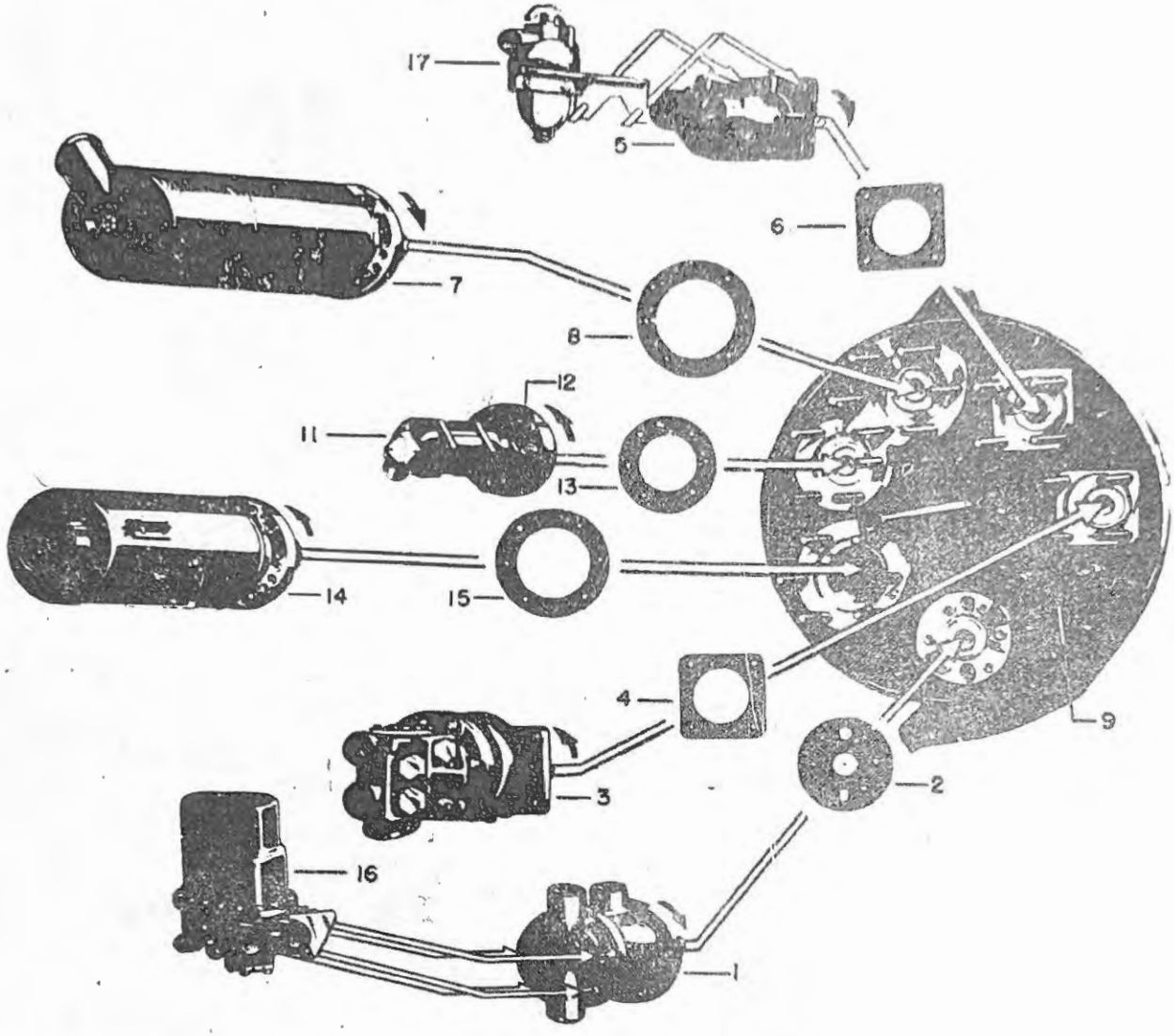
(b) Install fuel manifold to engine. (Fig. 40)

1. Secure by attaching brackets to remaining studs without nuts. (Excepting those in line with combustion chambers No. 7 and No. 14)

2. Install 3/8"-24 nuts over brackets.

3. Install drip valve to fitting at the bottom of the fuel manifold. (Fig. 39)

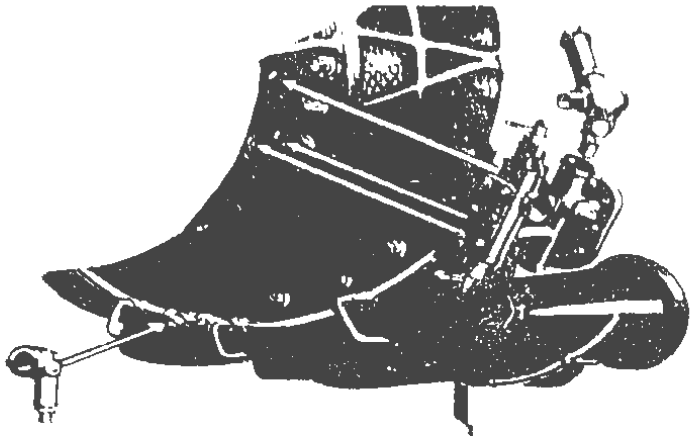
(12) Install spark plugs.



(1) Lube Pump
(2) Gasket
(3) Governor
(4) Gasket
(5) Fuel Pump
(6) Gasket
(7) Generator
(8) Gasket
(9) Starting Fuel Pump Pad
(10) Gasket
(11) Tachometer Generator
(12) Tachometer Generator Adapter
(13) Tachometer Generator Gasket
(14) Starter Assembly
(15) Gasket
(16) Barometric
(17) Lube Filter

INSTALLATION OF ACCESSORIES

FIG. 38



INSTALLATION OF CONTROL VALVE

FIG. 39

(a) Install gasket and plug in air adapters No. 7 and No. 14.

NOTE: PLUG IS INSTALLED WITH HOLE IN SHROUD TOWARD THE DOME.

(b) Secure with two (2) 1/4"-28x1/2" long cap screws.

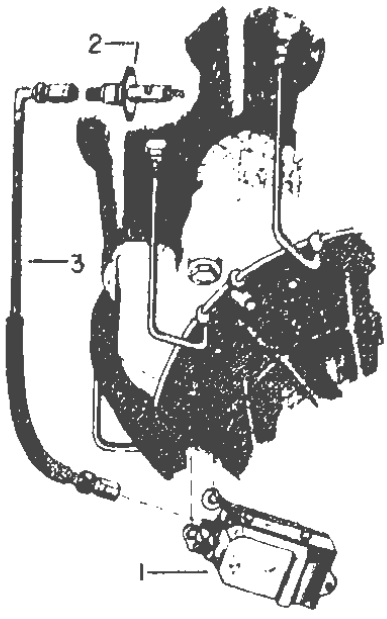
(c) Attach shielded cable from coils to plugs.

d. INSTALL OUTSIDE PIPING ASSEMBLY. (FIG.'S 41 and 42)

(1) Install drain from fuel pump to governor (5).

(a) Attach line to the lowest of the four drains in the fuel pump flange, and to the fitting on the governor flange.

(2) Install drain from governor mounting flange to governor casing drain (6).



(1) Ignition Coil.
(2) Spark Plug
(3) Ignition Lead

INSTALLATION OF IGNITION ASSEMBLY

FIG. 40

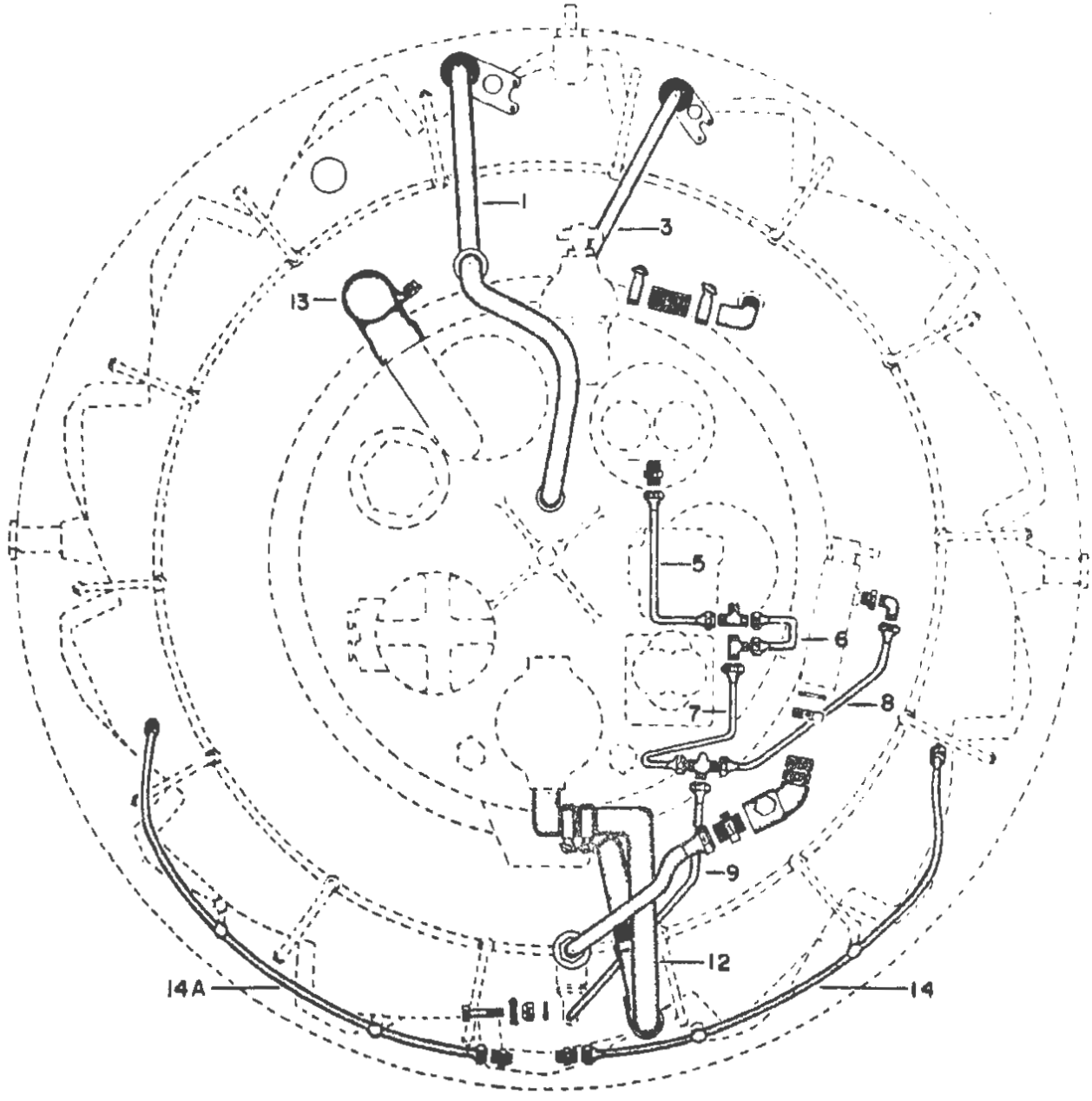
(3) Install line from governor casing to starting pump cover pad (7).

(a) This line attaches to the pump pad tee fitting on the side away from the control valve.

(4) Install line from control valve to starting pump pad (8).

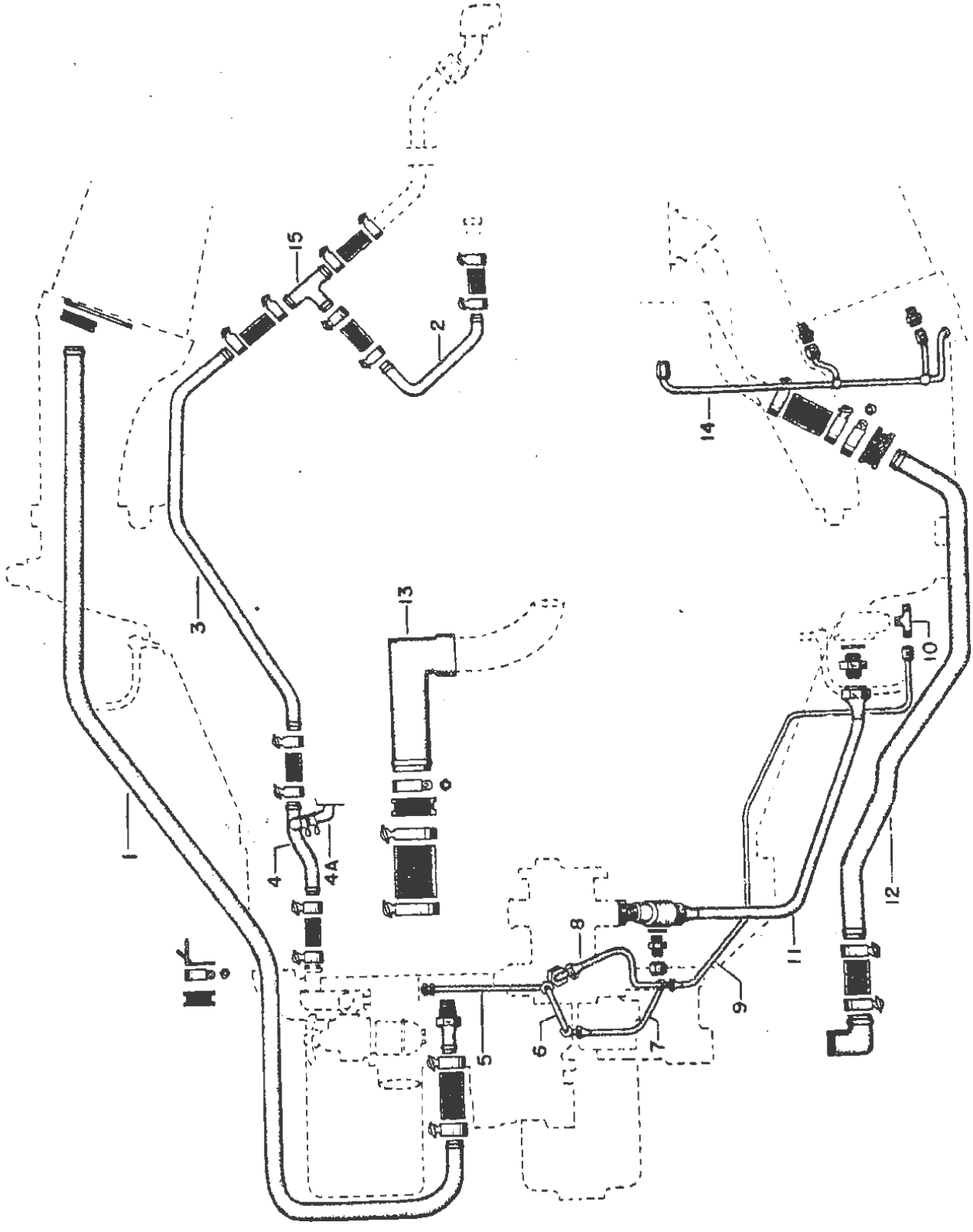
(a) Attach line to side of fitting opposite the line from governor casing.

(5) Install line from pad to drip valve (9).



ASSEMBLY OF OUTSIDE PIPING

FIG. 41



ASSEMBLY OF OUTSIDE PIPING

(6) Install line from control valve to drip valve (11).

(a) Tighten to specifications (Section 5 of this manual).

(7) Install turbine bearing scavenge oil line (12).

(a) Install grommet and bracket on line and attach to air baffle.

(b) Attach to scavenge fitting with hose and clamps.

(c) Attach other end to lower pump fitting.

(8) Install oil pressure lines (2), (3), (15), and (4).

(a) Install (2) to fitting (15) and fitting to rear turbine bearing line.

(b) Install (3) to (15) and to (4).

(c) Attach fitting (4a) to front compressor bearing fitting.

(d) Attach (4) to lube filter fitting.

(9) Attach accessories casing vent line.

(a) Install bracket assembly to vent line and to rear of accessories casing to compressor bearing support split line.

(10) Install combustion chamber drain lines (14) to combustion chambers 5 to 11, inclusive, and to drain valve.

(11) Install generator cooling air duct assembly (13).

e. INSTALL ACCESSORIES PIPING ASSEMBLY. (FIG. 43)

(1) Install oil return line (15) to outer fitting on pump and to accessories casing fitting on right rear of casing.

(2) Install oil pressure line (16) to rear fitting of pump and to the fitting next to the handle of the lube filter, and to the front.

(3) Install pressure line (17) from filter to accessories gear casing.

(4) Install fittings into the remaining accessories as follows:

(a) Install fitting (26) into port of fuel pump marked "IN".

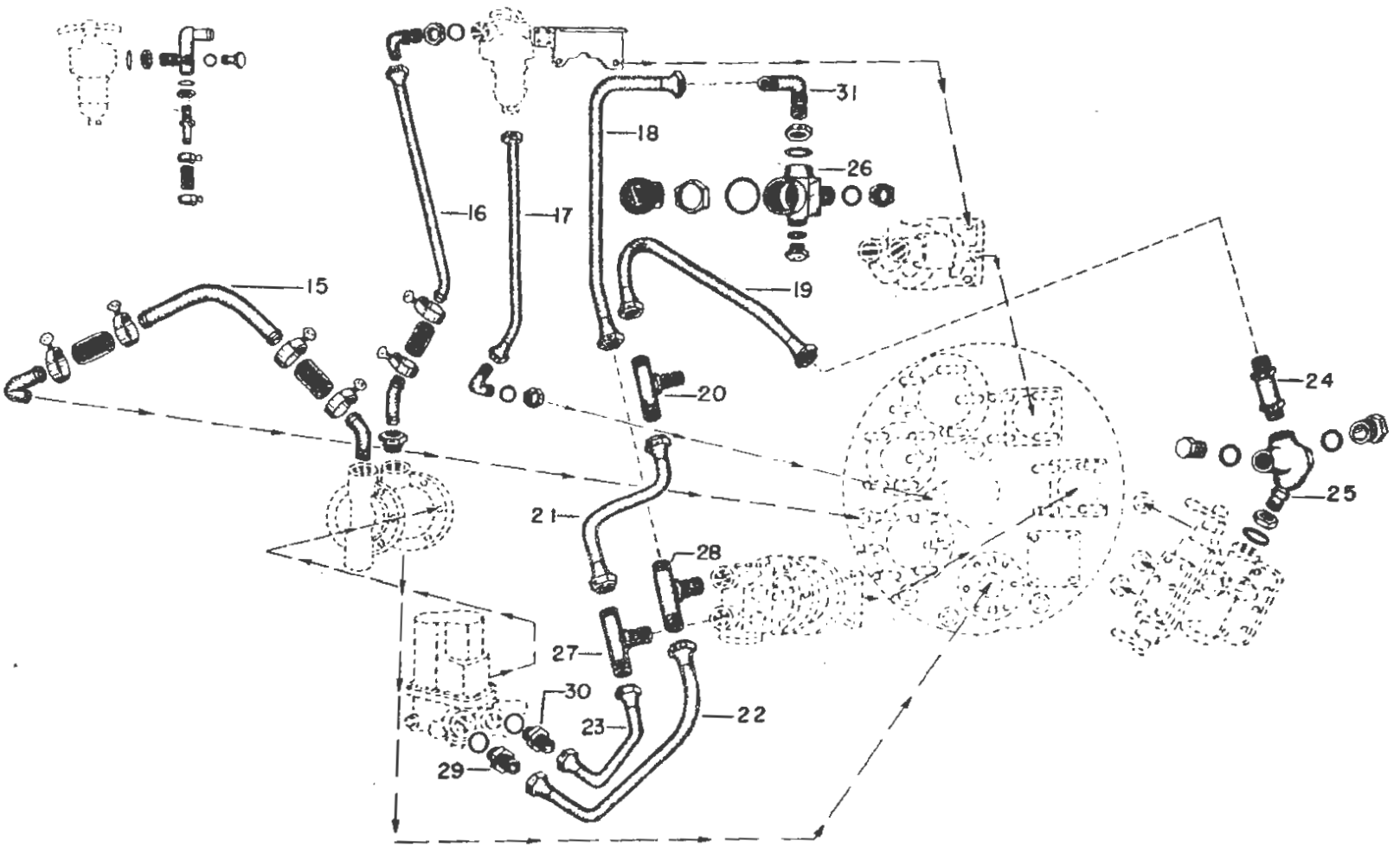
(b) Install fitting (20) into port of pump marked "OUT".

(c) Install fittings (27) and (28) into governor.

(d) Fittings (29) and (30) should be installed in barometric if they have been removed.

(5) Install fuel pump to governor pressure line.

(a) Install line (21) to fittings (20) and (27).



INSTALLATION OF ACCESSORIES PIPING ASSEMBLY

FIG. 43

(6) Install governor to barometric pressure line.

(a) Install line (23) to fittings (27) and (30).

(7) Install barometric to governor by-pass line.

(a) Install line (22) to fittings (29) and (28).

(8) Install governor to fuel pump by-pass line.

(a) Attach line (18) to fittings (28) and (30).

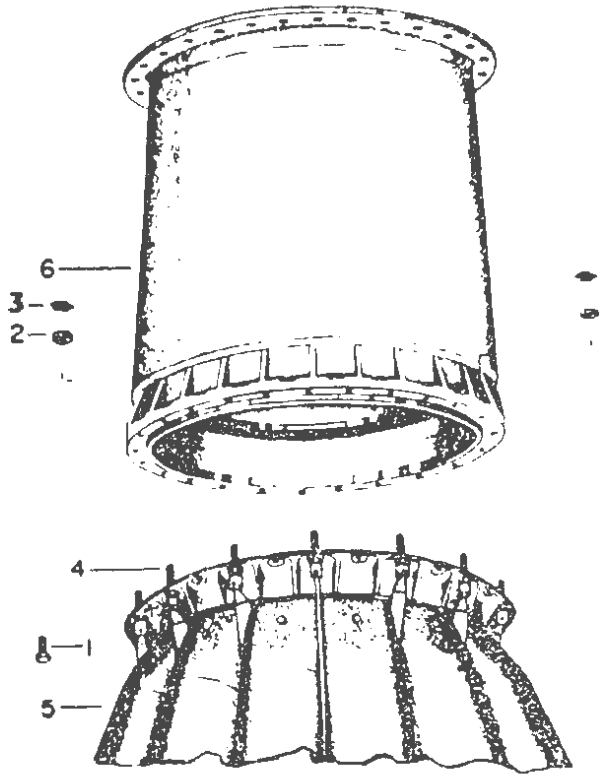
(9) Install fuel pump to control valve pressure line.

(a) Attach line (19) to fitting (20) and to check valve (24) which has been assembled into fitting (25).

f. INSTALL EXHAUST CONE ASSEMBLY TO ENGINE. (FIG. 44)

(1) Install exhaust cone.

(2) Secure with fourteen (14) nuts and pal nuts on the tie strap clevices and twenty-eight (28) special bolts, special nuts and pal nuts.



(1) Bolt
(2) Nut
(3) Pal Nut
(4) Clevice
(5) Ring and Tube Assembly
(6) Exhaust Cone

INSTALLATION OF EXHAUST CONE

FIG. 44